metal finishing journal

...NT APPLICATION, ELECTRODEPOSITION, VITREOUS ENAMELLING, ...LVANIZING, METAL SPRAYING and all METAL FINISHING PROCESSES.

Vol. 3 No. 31 (new series) JULY, 1957


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ENGINE DIVISION (RODNEY WORKS)
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1st December, 1954.

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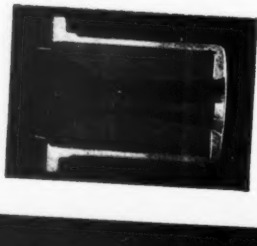

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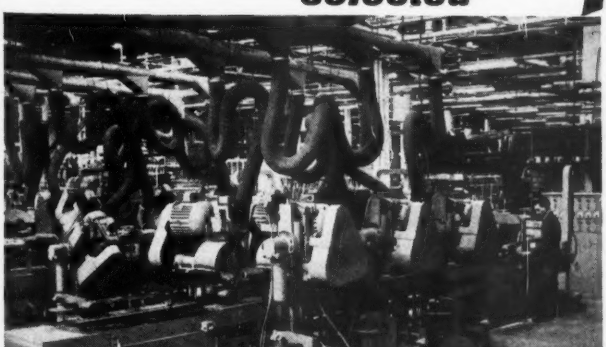
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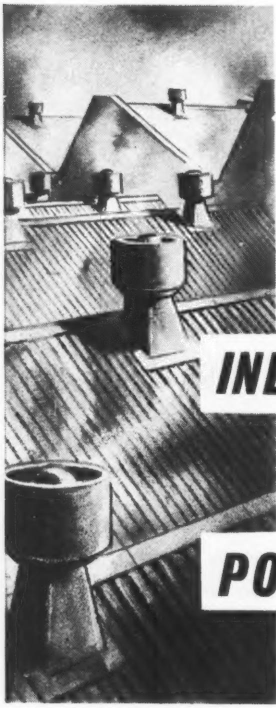

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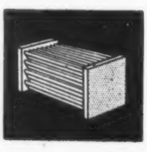

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THIS JOURNAL IS DEVOTED TO THE SCIENCE AND TECHNOLOGY OF PAINT APPLICATION, ELECTRODEPOSITION, VITREOUS ENAMELLING, GALVANIZING, ANODIZING, METAL SPRAYING & ALL METAL FINISHING PROCESSES. THE EDITOR IS PREPARED TO CONSIDER FOR PUBLICATION ANY ARTICLE COMING WITHIN THE PURVIEW OF "METAL FINISHING JOURNAL" AND ALL SUCH ARTICLES ACCEPTED WILL BE PAID FOR AT THE USUAL RATES.

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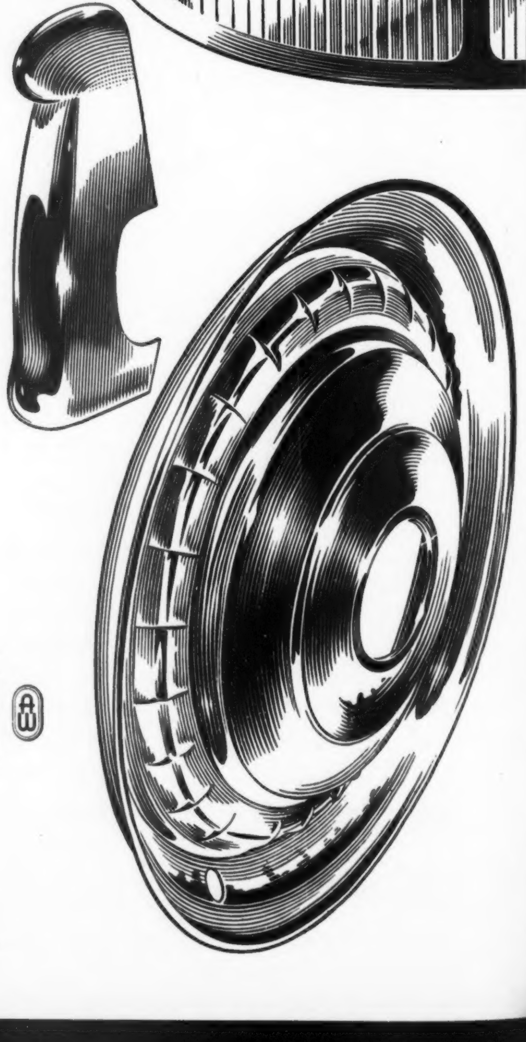

INDUSTRIAL METABOLISM

IN the course of fundamental research into the metabolic processes of the human body very exact analyses have been made into the efficiency with which foodstuffs and oxygen are utilized in the production of energy and of bodily tissues. This has been done by exact measurements of input, output and bodily gains.

It would be a highly instructive exercise, were it economically possible, to conduct a similar analysis in respect of the productive efficiency of a works. This would involve making a complete record, over a statistically significant period, of the consumption of raw materials and energy, whether in the form of manpower, fuel, or electricity. This total should be equated to the output of finished goods, the production of scrap, and of waste products.

Such a survey might be expected to reveal, at least in the case of the majority of well administered works, that the conversion ratio of raw materials to finished product is satisfactory. Also, within the limits imposed by working agreements, the utilization of manpower, in general, is not excessively wasteful. It is, however, in the field of fuel utilization and the disposal of industrial by-products and so-called waste materials that some of the most startling discrepancies may appear. Large amounts of fuel, for example, can be wasted by inefficient and out-of-date steam raising plant, or by the employment of inadequately skilled boilerhouse staff. Quantities of heat poured into workshops to maintain the ambient temperature at a comfortable level may be lost to the outer air through ill-designed ventilating equipment or improper use of doors and windows.

Excessive drag-out from plating tanks leads to the loss of expensive chemicals, and this together with the disposal of acid pickling liquors rejected because of high metal content, becomes doubly uneconomic because of the need for treatment of the liquid effluent prior to discharge. There is some evidence of increasing awareness of the significance of these losses in the shape of more general use of drag-out tanks being used for solution make-up, although little attempt is yet made to recover sulphur or sulphuric acid from waste pickle liquor. Admittedly such recovery would have to be on a fairly large scale to be in any way economical, but there would appear to be considerable opportunities for co-operative action in this respect.

Spray-painting operations are also apt to give rise to excessive wastage, as much as 60 per cent. of overspray being produced in the coating of certain types of article, and very little of this excess material is recoverable. Similarly, a high proportion of the volume of paint applied by spraying consists of the volatile solvent, which is evaporated either at room temperature or in a stoving oven. The solvent vapours thus produced being undesirable constituents of the workshop atmosphere are vented to the outer air through the medium of an efficient exhaust system.

The need for exhausting large volumes of contaminated air increases the cost of space heating, while the solvent vapours represent a loss of combustible material which hitherto has been irrecoverable. The whole subject of atmospheric pollution and the possibility of treatment of gaseous effluents is only now coming to receive serious technical attention. The possibilities inherent for example, in catalytic oxidation of combustible gases at low concentrations, may considerably reduce wastage from this source. It is to be hoped that developments of such other processes as ion exchange may lead to an increase in the recoverability of other costly materials.

Talking Points by "PLATELAYER"

TOPICAL COMMENT FROM THE MAIN LINES AND SIDE LINES OF METAL FINISHING

GERMANIUM CALLING

AN interesting sidelight on the recent correspondence in these columns on the use of motor-generators for electroplating is that there are now more than 30 million watts of direct current supplied by germanium rectifiers in the United States. In this country there are few, if any, germanium rectifiers in use yet in electroplating.

We thus have a position which may be summed up roughly as follows: in Europe, the motor-generator appears to be regarded as entirely obsolete as a source of current for electroplating, having been replaced by the selenium rectifier. Across the Atlantic, on the other hand, motor-generators are in common use and are still being installed, having by no means been ousted by the selenium rectifier, which is itself becoming regarded as obsolescent.

Germanium rectifiers are, however, generally air-cooled, so that they can only be installed with safety in a relatively dust-free location or they will clog up with dirt and burn out or even catch fire. This is a real disadvantage, and those who recall the trouble from this cause with the early air-cooled copper-oxide rectifiers may well have qualms about them.

Germanium rectifiers operate at higher voltages than selenium, while the silicon rectifier, of which we shall certainly hear more, operates at still higher voltages and temperatures.

The plating industry in this country will almost certainly prefer to have rectifiers of any type either oil or water cooled.

SUPER MARKET

EVERY so often we read in the press about further talks on the subject of the European Free Market and there is some inclination to view the matter as some airy scheme which may or may not come to pass in the distant future. This is far from being the case, and the target date for the start of the free trade area is less than a year ahead. Following this, all tariffs and quotas in Europe would be abolished in three stages of four years each if everything goes according to plan. There would thus be a market for the free circulation of goods of all kinds amongst 240 million consumers, as against 165 million in the U.S.A. The catch is that the spending power of the average European is only half that of his Transatlantic counterpart, but this will no doubt change in time.

If, as has often been said, it is the finish that sells the goods, we should have little to fear, because British industry is particularly well equipped in the field of finishing plant and know-how, particularly where mass-production methods are concerned. We shall, however, have to be on our toes to see that the advantage is not lost.

BUILD-UP

IS complexity a selling point? It may be argued that a complicated machine or process may sound so impressive that the prospective purchaser will automatically think that it must be superior to the older and more elementary alternative available. Certainly, there has, in recent years, been a tendency towards the complication—perhaps the over-complication—of devices of all kinds. These thoughts are occasioned by the announcement in the press of a new process which consists of a three-stage operation combining phosphating and plating. According to the information available, steel articles are apparently phosphate-treated with the application of current to give a coating which can be up to 0·007 in. thick, and this is followed by what is described as an alloy deposit combined with an after-treatment. That plating can be carried out on phosphate coatings is quite well known, the cathodic reaction enabling adhesion to take place by the reduction of the phosphated surface. The relevant point in this instance is, however, whether the resulting finish is superior in performance, better looking, or cheaper than normal zinc or cadmium plate applied by conventional methods, otherwise there can be no reason for introducing it.

BUSY BISRA

THE British Iron and Steel Research Association is certainly doing yeoman work on the finishing of steel. Last month some impressive small scale production lines carrying out such operations as the plastic coating, and tinning, of steel sheet by experimental methods now in the course of development were shown at Sketty Hall to an interested audience.

The question that springs to mind is: "What happens next?" There seems to have been a strange reluctance on the part of the steel industry—or anyone else for that matter—to commercialize the apparently attractive processes developed by BISRA in recent years. One cannot help wondering why.

METAL COATING RESEARCH at the SKETTY HALL LABORATORIES of the British Iron and Steel Research Association

THE only research laboratory in this country entirely devoted to investigations relating to the surface coating of metal is the Sketty Hall laboratory of the British Iron and Steel Research Association at Swansea. Last month this laboratory held two open days during which visitors were enabled to study work in progress in the coating and finishing field.

The laboratory was set up in 1946 under the direction of Mr. D. Luther Phillips, who retired in 1954. There are now about 30 people working in the laboratory, with Mr. S. S. Carlisle as director, with Mr. W. Bullough, Dr. M. L. Hughes, Dr. F. W. Salt, and Mr. A. G. Shakespeare as senior investigators.

The primary objectives of the work of the laboratory are:

(*a*) To develop new and improved coatings, both metallic and non-metallic for steel in order to maintain and extend the applications of steel products.

(*b*) To improve processes for strip tinning, galvanizing, aluminizing and lacquering, in order to reduce processing costs, increase productivity and improve quality. This includes developing the technology of strip processing to prepare the way for automation in the steel strip finishing industry.

The Work of the Laboratory

The past and present research programme can be considered under seven main headings: surface preparation; surface physics; coatings by electro-deposition and allied methods; organic coatings; hot-metal coating practice; investigation of the properties of coatings; and strip processing technology.

Surface Preparation

Acid pickling is a very important process in surface preparation and a considerable amount of work has been done by the laboratory on the subject, including investigations into the effect of pickling conditions on weight loss and surface roughness, and the recovery of sulphuric acid from waste pickle liquor.

Gas pickling of steel has been investigated because it appears to have been used successfully in the U.S.A. on some galvanizing plants. It was said to give a good surface for coating and avoid the production of embarrassing quantities of waste effluent. The steel is heated to 730° C in a gas consisting of 70 per cent. nitrogen, 20 per cent. hydrochloric acid and 10 per cent. carbon dioxide. The process was only suitable for removing very thin oxide films, such as those on cold-reduced sheet, because there are no suitable inhibitors available. If there were any appreciable thickness of scale the attack on the surface would not be uniform, with consequent increase in roughness and heavy losses of metal(1).

The method of reducing surface oxide films by heating to about 750° C in a strongly reducing atmosphere such as cracked ammonia is being employed in the laboratory on the new continuous hot strip-tinning process, and some research is being carried out to determine the minimum temperature and time of treatment necessary. This process has the great advantage of using no corrosive gas or liquid; plant design is thus simplified.

Surface Physics

The physical condition of the surface of steel, particularly its smoothness, has an important effect on the protective property of coatings applied to it. The present trend towards thinner coatings requires continual improvement in surface finish, and thus measurement of surface finish and methods of smoothing are important.

Among many other matters that are of direct concern to coatings research and so have received attention in the laboratory are the influence of the base metal structure on the crystal structure of thin electrodeposits and techniques of measuring the thickness and composition of very thin coatings.

Measurement of Surface Smoothness

The surface roughness (Talysurf) of the highly

finished steel sheet now used in tinplate manufacture is from 5 to 10 micro-inches R.M.S., and a coating of ½ lb. per basis box of tin, which is now commonly used in the U.S.A. for food cans, is only 15 micro-inches thick. It is obvious that even the present-day surface roughnesses must to some extent be limiting the effectiveness of the thinner coatings. Research has, therefore, been started at Sketty Hall into techniques of surface smoothing.

It was soon found that neither the Guild Photometer nor the Talysurf was satisfactory for assessing the surface smoothing treatments, because several electropolishing treatments showed an increase in surface roughness by the Talysurf, but an improvement in lustre of surface as shown by eye or the Guild. Consequently, an alternative method has been developed which now seems satisfactory. The roughness is assessed from the effective area of the surface as determined by measurement of its electrode capacitance. The principle is that the electrode capacitance of a metal surface in an electrolyte is related to the effective surface area and can be measured by determining the quantity of electricity required to raise to a given value the potential of the steel specimen acting as a cathode in anaerobic 0·1 N sodium carbonate. The quantity of electricity can be measured with a ballistic galvanometer and the ratio of the areas of surfaces assessed from the ratio of galvanometer throws.

This method is being used to study the efficiency of various smoothing baths and the influence of time of treatment and current density. Some baths show an increase in "roughness" during the first minute of treatment, followed by a considerable decrease in the following few minutes to a value about one-third of that of the original steel.

The Structure of Electrodeposited Coatings on a Single-crystal Iron Base

Properties of electrodeposits, such as adhesion, hardness and brightness, are a function of crystal structure. The crystal structure of thin deposits can be affected by the substrate and the conditions of deposition. The structure of some electrodeposits was studied in the laboratory some years ago([2]). Electropolished single crystals of iron were used as substrates and thin layers of zinc, copper, nickel and tin were electrodeposited on them under such conditions that the coatings were also single crystals. Although the single crystals used as substrates for the first three metals had various high-index planes in the surface, certain planes in the deposit were always parallel to 110 planes in the iron. Thus the basal (0001) plane of the hexagonal zinc crystal was parallel to the (110) plane of the body-centred cubic iron crystal. It was considered that electropolishing produced small facets on low-index planes on the iron surface inclined to the general surface direction and that deposition took place initially on these.

The tin was electrodeposited on single crystals of iron. One was cut so that the (100) plane was parallel to the surface; on this iron crystal the (100) plane of tin and the (100) plane of iron were parallel. A second crystal was cut so that the (110) plane was parallel to the surface; on this crystal the (110) planes were parallel.

Measurement of Tin Coating Thickness by X-rays

Orthodox stripping techniques were found to be very laborious for measuring the thickness of tin coatings on samples during research on hot-strip tinning. Furthermore, with the stripping method relatively large areas had to be sampled to obtain the required accuracy, and thus local variations in coating thickness were often masked. Consequently, development work was undertaken on the X-ray fluorescence method for determining coating weight. This technique originated in the U.S.A. An X-ray beam illuminates the surface under study. Its wavelength is chosen to induce fluorescence of the iron base but not of the tin. The iron fluorescence shines back through the tin but is attenuated according to the thickness of the tin. Thus by measuring the resultant fluorescent or background radiation with a Geiger counter or by some other means, the thickness of the coating can be determined after the apparatus has been calibrated against standard samples. In the apparatus developed at Sketty Hall([3]), the X-ray beam is arranged to illuminate only a small area, about 1/10-in. in diameter, so that the uniformity of a coating can be studied on a small scale. Also a standard specimen is periodically inserted into the X-ray beam close to and parallel to the sample being measured, so that the detector receives radiation alternately from the standard specimen and from the unknown sample. The coating weight is obtained from the ratio of the two readings. This arrangement compensates for any slow variations in the intensity of the source or in the sensitivity of the detector. The accuracy of the method is found to be about $\pm\frac{1}{4}$ oz. per basis box on typical 8-oz. per basis box material. An apparatus suitable for use in a tin-plate works is now being manufactured by Newton Victor Ltd.

New Coatings by Electrodeposition and Related Methods

The electrodeposition of most single metals has been thoroughly studied, but there is still much scope for work on the electrodeposition of metal alloys. The alloy deposit is often found to have useful properties quite different from those of the metals composing it. Electrodeposition of aluminium has also been investigated, and alternative coating procedures such as electrophoresis and vapour-phase coating are being studied.

Iron-Zinc Alloys

It has been found that co-deposits of iron and zinc on steel of certain compositions have superior corrosion resistance to that of pure zinc. A method has been developed by which coatings of composition from 3 per cent. zinc to 90 per cent. zinc can be deposited using a double anode system([4]). A coating of 6 per cent. zinc is nearly as reflective as a perfect mirror; it adheres well to the steel sheet and has a smoothing effect, that is, the coating is deposited first in the hollows of the steel. A mirror surface can be obtained on an etched plate without buffing. The coatings can be deposited at the rate of about 0·0001 in. per min., and have a hardness of 560 D.P.N. The alloy surface does not tarnish indoors, but does not resist corrosion sufficiently well to be used outdoors. An alloy containing 63 per cent. zinc has a lustrous surface and a hardness of about 300 D.P.N., and it can be deposited at about the same rate as the 6 per cent. alloy. Preliminary tests suggest that it will resist outdoor corrosion well. A coating of this alloy deposited on a steel sheet has been buffed to a mirror brightness and chromium-plated. The resultant finish is shown in Fig. 1.

Several specimens of each of the alloy coatings in the range 10 to 90 per cent. zinc have been prepared and are now being given long-term atmospheric exposure tests. Tests are also in progress to establish the corrosion resistance of a chromium-plated specimen using a 60 per cent. iron-zinc alloy as an undercoating.

The industrial application of these coatings is being encouraged, and one firm is now developing the process further as a base for painting on steel sheet.

Iron-Tin Alloy Deposits

The interesting properties of iron-zinc co-deposits encouraged an investigation into co-deposits of iron and tin. It was found difficult to co-deposit these metals over a wide range of composition, but a technique was worked out in which alternate thin layers of the two metals were deposited, and the resultant multilayer system was heated to diffuse the metal constituents thermally. By this means coatings having a range of compositions were produced. It was observed that the hydrogen overvoltage of the surface of such deposits rose rapidly with increasing tin content so that at 30 per cent. (wt.) of tin an overvoltage of 0·69 V. was found, compared with 0·72 V. for pure tin and 0·32 V. for pure iron. This relatively high overvoltage at low concentrations of tin and the fact that the electrode potential of the iron-tin deposit is close to that of iron suggested that these coatings might be only slightly inferior to tin in their resistance to acid food packs, and so might permit a considerable saving of tin in tinplate for can manu-

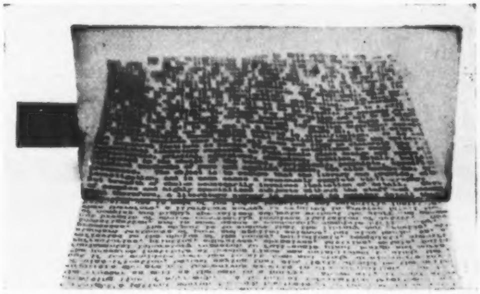

Fig. 1.—Demonstration of mirror finish obtainable on iron-zinc alloy plate

facture. Corrosion tests indicate that, although the coatings of 35 per cent. tin and above show good resistance (as measured by rate of hydrogen evolution) in a malic acid buffer, they do not resist attack by any acid fruit syrup as well as might be expected, probably because of the action of other corrosion accelerators in these syrups. The iron-tin coatings do, however, show a resistance to attack by some alkali detergents which is much superior to that of pure tin. Hence their possible uses are being further studied as well as their resistance to non-acid food packs such as baked beans, peas and some soups.

The Identification of Differentially Coated Electrolytic Tinplate

Tinplate with a thicker coating of tin on one side than the other is used for can making in the U.S.A. and is expected to come into use here. By this means a 4-oz. coating can be used on the outside of a can, which is adequate protection, and a 16-oz. coating used on the inside to give the protection required for some packs, *e.g.*, acid fruits. As both surfaces are normally lustrous there would be a possibility of confusion in the can-making plants unless one side were marked in some way. Some marking processes in which one face is dulled are used in the U.S.A., but none is completely satisfactory. A new process being developed at Sketty Hall promises to be superior to any so far used. A thin electrodeposit of iron about 0·25 micro-inches thick is applied to one face after tinning but before flow brightening. It has the effect of dulling that side, so as to identify it. The marked surface has a corrosion resistance equal to that of tinplate, can be soldered and takes lacquer well, apparently better than a pure tin surface. This new method of marking is being assessed by the Metal Box Co. Ltd., and is the subject of a joint patent applied for by BISRA and the Steel Company of Wales Ltd.

The Electrodeposition of Aluminium

Electrodeposition is well suited for applying to steel aluminium coatings intermediate between the thickest evaporated deposits (about 20 micro-

finished steel sheet now used in tinplate manufacture is from 5 to 10 micro-inches R.M.S., and a coating of ¼ lb. per basis box of tin, which is now commonly used in the U.S.A. for food cans, is only 15 micro-inches thick. It is obvious that even the present-day surface roughnesses must to some extent be limiting the effectiveness of the thinner coatings. Research has, therefore, been started at Sketty Hall into techniques of surface smoothing.

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Iron-Zinc Alloys

It has been found that co-deposits of iron and zinc on steel of certain compositions have superior corrosion resistance to that of pure zinc. A method has been developed by which coatings of composition from 3 per cent. zinc to 90 per cent. zinc can be deposited using a double anode system([4]). A coating of 6 per cent. zinc is nearly as reflective as a perfect mirror; it adheres well to the steel sheet and has a smoothing effect, that is, the coating is deposited first in the hollows of the steel. A mirror surface can be obtained on an etched plate without buffing. The coatings can be deposited at the rate of about 0·0001 in. per min., and have a hardness of 560 D.P.N. The alloy surface does not tarnish indoors, but does not resist corrosion sufficiently well to be used outdoors. An alloy containing 63 per cent. zinc has a lustrous surface and a hardness of about 300 D.P.N., and it can be deposited at about the same rate as the 6 per cent. alloy. Preliminary tests suggest that it will resist outdoor corrosion well. A coating of this alloy deposited on a steel sheet has been buffed to a mirror brightness and chromium-plated. The resultant finish is shown in Fig. 1.

Several specimens of each of the alloy coatings in the range 10 to 90 per cent. zinc have been prepared and are now being given long-term atmospheric exposure tests. Tests are also in progress to establish the corrosion resistance of a chromium-plated specimen using a 60 per cent. iron-zinc alloy as an undercoating.

The industrial application of these coatings is being encouraged, and one firm is now developing the process further as a base for painting on steel sheet.

Iron-Tin Alloy Deposits

The interesting properties of iron-zinc co-deposits encouraged an investigation into co-deposits of iron and tin. It was found difficult to co-deposit these metals over a wide range of composition, but a technique was worked out in which alternate thin layers of the two metals were deposited, and the resultant multilayer system was heated to diffuse the metal constituents thermally. By this means coatings having a range of compositions were produced. It was observed that the hydrogen overvoltage of the surface of such deposits rose rapidly with increasing tin content so that at 30 per cent. (wt.) of tin an overvoltage of 0·69 V. was found, compared with 0·72 V. for pure tin and 0·32 V. for pure iron. This relatively high overvoltage at low concentrations of tin and the fact that the electrode potential of the iron-tin deposit is close to that of iron suggested that these coatings might be only slightly inferior to tin in their resistance to acid food packs, and so might permit a considerable saving of tin in tinplate for can manufacture.

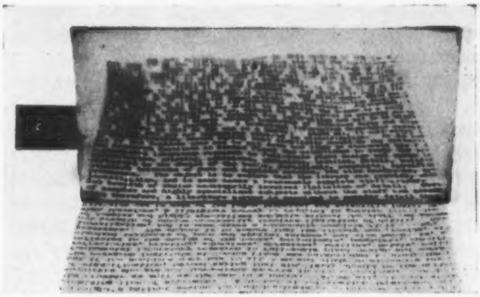


Fig. 1.—Demonstration of mirror finish obtainable on iron-zinc alloy plate

Corrosion tests indicate that, although the coatings of 35 per cent. tin and above show good resistance (as measured by rate of hydrogen evolution) in a malic acid buffer, they do not resist attack by any acid fruit syrup as well as might be expected, probably because of the action of other corrosion accelerators in these syrups. The iron-tin coatings do, however, show a resistance to attack by some alkali detergents which is much superior to that of pure tin. Hence their possible uses are being further studied as well as their resistance to non-acid food packs such as baked beans, peas and some soups.

The Identification of Differentially Coated Electrolytic Tinplate

Tinplate with a thicker coating of tin on one side than the other is used for can making in the U.S.A. and is expected to come into use here. By this means a 4-oz. coating can be used on the outside of a can, which is adequate protection, and a 16-oz. coating used on the inside to give the protection required for some packs, *e.g.*, acid fruits. As both surfaces are normally lustrous there would be a possibility of confusion in the can-making plants unless one side were marked in some way. Some marking processes in which one face is dulled are used in the U.S.A., but none is completely satisfactory. A new process being developed at Sketty Hall promises to be superior to any so far used. A thin electrodeposit of iron about 0·25 micro-inches thick is applied to one face after tinning but before flow brightening. It has the effect of dulling that side, so as to identify it. The marked surface has a corrosion resistance equal to that of tinplate, can be soldered and takes lacquer well, apparently better than a pure tin surface. This new method of marking is being assessed by the Metal Box Co. Ltd., and is the subject of a joint patent applied for by BISRA and the Steel Company of Wales Ltd.

The Electrodeposition of Aluminium

Electrodeposition is well suited for applying to steel aluminium coatings intermediate between the thickest evaporated deposits (about 20 micro-

inches) and the thinnest hot-dipped coatings (about 1 mil). It is a possible process for making aluminized steel for container manufacture. It has the advantage over hot dipping that it does not entail heat treatment, which affects the mechanical properties of the steel substrate. This is important for aluminizing high-tensile steel wire for use as cores in aluminium cables. Some non-aqueous aluminium plating baths have been studied on an experimental continuous wire-plating line in the laboratories. Good adherent deposits have been obtained with an aluminium chloride in ether bath developed by the U.S. Bureau of Standards. The bath life is, however, short and further research is necessary to make the process economically practicable.

The Anodizing and Colouring of Aluminium-coated Steel

The oxidation of aluminium surfaces by anodic treatment in an acid bath is common practice and gives a hard protective surface to the aluminium. This film can be dyed to produce a range of colours. At Sketty Hall a suitable process of this type has been developed for anodizing the thin aluminium coating on hot-dip aluminized steel. A good surface on the aluminium is essential and so a high-quality aluminized material is needed. With suitable pretreatments fairly good coloured coatings were obtained on Armco aluminized steel. The process is a promising one for further development when hot-dip aluminized steel becomes commercially available in this country.

Vapour-phase Coatings

Metals can be deposited on a steel surface by chemical reaction between the hot steel and a vapour compound of the metal, but the rate of growth of the coating is usually low. Chromizing is such a process for forming a coating of chromium on steel from chromous chloride vapour. An investigation is being made of the mechanism of the vapour-phase process with the object of accelerating the rate of deposition. The deposition of titanium nitride on steel from titanium tetrachloride has been chosen as an example. An experimental apparatus has been built for coating strip in which steel strip, ½ in. wide and 0·004 in. thick, is directly heated by an electric current passed through it in an atmosphere consisting of titanium tetrachloride, hydrogen, and nitrogen. Coatings of pure titanium nitride have been obtained with deposition rates of about 10 micro-inches in 2 minutes. The coating has an attractive golden colour and is extremely hard and resistant to corrosion.

The Application of Coatings by Electrophoresis

By setting up an electrostatic field between electrodes immersed in a liquid, charged particles suspended in the liquid can be made to move through it and to discharge at the electrodes. This is the process of electrophoresis, and by it a wide variety of materials such as resins, metallic oxides metal powders and carbides can be deposited on metal surfaces, provided that the coating material is sufficiently finely divided for it to be suspended in the liquid. Owing to the large size of the particles in relation to the electrical charge they carry, the quantity deposited per coulomb is extremely large compared with electrodeposition, *e.g.*, 10 gm. per coulomb compared with less than 1 mg. per coulomb. Although the coating as deposited usually has poor adhesion, so that heat treatment is necessary to sinter or bond the coating to the base, the method is likely to be useful for applying uniform coatings of resins, plastics or metal oxides which can then be heat-treated to give the necessary bond. Exploratory experiments have been carried out in the laboratory on the deposition of magnesium oxide and polyvinyl chloride coatings on steel.

P.V.C.-coated Steel Laminate

By bonding a thin film of plastic such as polyvinyl chloride to flat steel sheet or strip a laminate is formed which combines the protective and decorative properties of P.V.C. sheet with the strength and cheapness of steel. Bonding procedures are now available which give a laminate that can be deep-drawn, roller-formed, sharply bent to form lock seams, crimped and punched or sheared without any damage to the surface of the plastic or the bond with the steel.

The potential uses of this material are innumerable. The total cost of the coating is likely to be comparable with that of a high-quality enamel finish, but since no expensive cleaning and treating procedures are necessary after fabrication of the component, there can be great savings in the total cost of fabrication and finishing of many articles which are now made as metal pressings or rolled sections and painted afterwards. The P.V.C. film coating resists abrasion, weather, and corrosion by moisture and chemicals better than paint or enamel. Furthermore, because of the heat insulation of the thicker film the P.V.C. surface is warm to touch, unlike painted steel. Another advantage is that minor blemishes on the surface of the steel which would be unacceptable for painting do not affect the quality of the laminate. Such a sheet laminate made on steel or non-ferrous metals is now being manufactured in the U.S.A. and is being increasingly used for such things as television and radio cabinets, calculating-machine cases, office and domestic furniture and equipment, and chemical containers. It is equally suitable for these and other uses in this country, such as for electrical switchboard panels, motor-car parts, and walling and panelling.

The BISRA Process for Production of "Plasteel"

In view of the importance of this laminate in the sheet-steel producing industry, work was started about 18 months ago at the BISRA laboratories at Swansea to develop a laminating process using British materials, with the hope of still further improving the properties of the laminate, particularly as regards the strength of the bond at high temperatures. As a result a special process has been developed for producing a laminate called "Plasteel". The process, which is protected by a patent, has been operated or a pilot plant consisting of a continuous strip-laminating line; it is capable of producing laminate 6 in. wide at a speed of about 10 ft. per min. Some hundreds of feet of sample material have been produced and it is now being examined by various firms that are potential users.

Pretreatment of the steel can include phosphating in the line if this is desired to give some protection on the uncoated side against rusting. The line has been designed to coat only one side of the strip with P.V.C. film, but there is no technical reason why both faces should not be clad. The adhesive is applied by a roller and the solvent is dried off and then "cured" in an electrically heated oven. The cured strip covered with adhesive is coated with the plastic film in a nip roll and then coiled.

Properties of the "Plasteel" Laminate

The excellent forming properties of the laminate have been stated. Plain and embossed films of various colours can be applied and the thickness of the film can be varied according to requirements. P.V.C. films as thin as 0·006 in. appear to be entirely satisfactory for many purposes.

Fig. 2 shows some examples of cups drawn from "Plasteel"; it also illustrates sharp bends, a lock seam and a roller-formed section. In all cases the plastic surface and the bond is quite undamaged by these treatments. It is generally found that in pressing and forming operations the limit is set by the behaviour of the steel rather than by the plastic or the bond.

Measurements of the adhesion of the coating have been made by peeling tests. The film is pulled back from the surface and the load required to cause separation is measured in lb. per in. width of the strip peeled. Films 0·006 in. thick break before they peel and so a figure cannot be quoted, but with thicker films adhesion strengths up to 30 lb. per in. have been measured. The actual value depends, of course, on the nature of the plastic film, which controls the geometry of the system in the peeling zone and so affects the apparent strength. It is, however, clear that strengths much lower in peel tests than 30 lb. per in. are adequate for satisfactory forming and pressing.

Laminates have been made with P.V.C. films with various proportions of plasticizer from 33 per cent. to none. A film of P.V.C. 0·01 in. thick without any plasticizer has a relatively hard surface, which is strongly resistant to chemical attack. Its ductility and the bond strength is, however, such that it can be severely worked by cold-forming without failure of the adhesion. Lightly plasticized materials seem to be the most generally useful and provide surfaces very resistant to scratching and abrasion and to most chemicals. They are available with various coloured, embossed and patterned finishes. It has been observed that these plastic coatings facilitate drawing operations because they appear to act as a lubricant in the die.

A unique and important characteristic of "Plasteel" laminate is that its bond strength is much

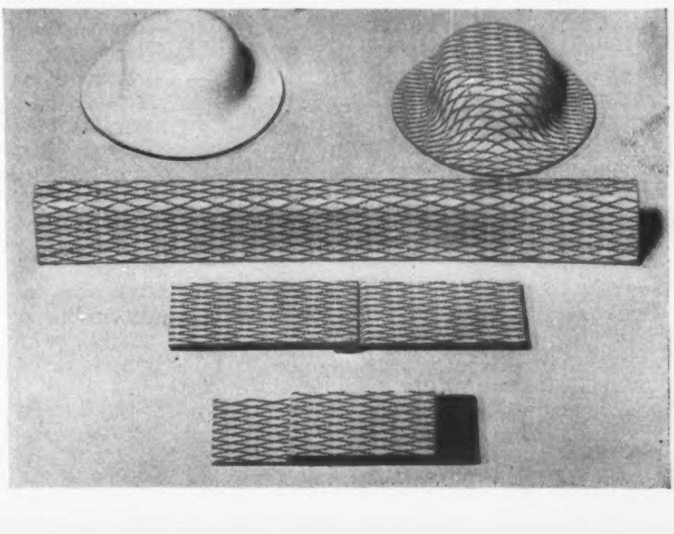


Fig. 2.—Some examples of drawn cups, bends, lock seams and roller-formed section in "Plasteel"

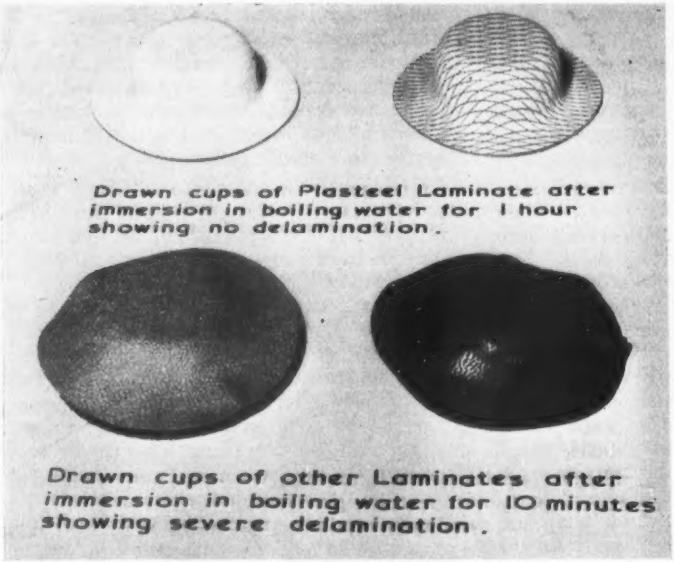


Fig. 3.—Results of boiling-water tests on "Plasteel" and other laminates.

greater at high temperatures than those that have been found for the laminates examined from other sources, made by other processes. For example, a deep cup pressed from "Plasteel" can be immersed in boiling water for an hour or more without any sign of peeling at the cut edges of the cup or anywhere else. Tests have also shown it to withstand immersion (in the stressed condition, as in a drawn cup) in glycerine at 200° C without any sign of peeling although, as is to be expected at this temperature, there is some discolouration of the plastic film. All other samples of P.V.C.-on-steel laminate peeled at the edges of the cup after only a few minutes immersion in boiling water. This property of hot strength in the bond is obviously of great value when applications are considered which might result in exposure of the laminate to heat. Such conditions might arise in its use for roofing material in strong sunlight or for exposed areas on shipboard, and for domestic furniture which may be exposed to radiation from domestic fires. Fig. 3 shows the results of boiling-water tests on various laminates compared with "Plasteel". The superior properties of "Plasteel" are due to the special laminating process developed by BISRA.

So far experiments have been carried out on a limited range of plain and embossed plastic films made available by the manufacturers for experimental purposes. Development work is still continuing to determine the properties of the most suitable film for lamination by this process. For example, when previously embossed film is laminated, it is necessary that the embossing be done in such a way that it is retained when the film is heated during the laminating process. The temperature to which an embossed film can be raised without removing the emboss thus becomes a very important property. An important feature of the BISRA process is that it can give good adhesion at a lower temperature than is the case with other known processes and hence can more easily retain the emboss.

Investigations so far carried out in the laboratory and on the pilot line indicate that the "Plasteel" process will be capable of producing a laminate suitable for any of the uses anticipated for a P.V.C.-coated sheet, and that it can do this using materials available in this country.

Some hundreds of feet of laminate, 3 in. wide, have been produced on the pilot line and submitted to potential users for their assessment. Negotiations are proceeding with member firms for the manufacture of "Plasteel". The investigations now being carried out will give guidance on what type of product to manufacture initially, *i.e.*, whether it should be in the form of strip or sheet and what dimensions, colours, or embossed patterns, etc., should be chosen.

In parallel with the commercial development of the process, BISRA is continuing research into further refinement of the process as well as investigating other P.V.C. coating processes, such as those using a plastisol, which would be particularly suitable for coating wire and tube.

Continuous Strip Lacquering

An experimental strip-lacquering line has been built. The arrangement consists of a vapour degreasing stage, a differential-speed type roller

coater and a lacquer curing furnace in which the strip can be heated up to 350° C by passing an electric current through it. Coatings of epoxy resins from less than 0·1 mil up to 0·5 mil thick have been applied. The curing times used have ranged from 20 sec. upwards. The work has shown that steel can be protected with a coating as little as 0·15 mil thick. A method has been found for almost completely eliminating the longitudinal ridging which forms on a roller-coated lacquer surface. This makes it possible to cure the applied lacquer rapidly without having to allow time for the ridging to flow out. It has also been found that, with the lacquers employed, the coating ductility is at its best with curing times of 1 min. or more.

Hot-metal Coating Practice

For the application of thick coatings there is obvious economic advantage in hot-dip coating rather than electrodeposition. There is also the possibility that the hot coating technique can be improved and adapted to high-speed strip working and for the application of thinner coatings, so as to compete with electrodeposition for tinplate production. Many aspects of hot-metal coating practice have been investigated in the laboratory, including the viscosity of molten non-ferrous binary metal alloys, the mechanism of coating thickness control by nip rolls in a tinning unit grease-pot, and, more recently, a new method of hot-strip tinning.

Study of the Viscosity of Molten Metals

Because the viscosity of the molten zinc in a galvanizing bath can influence the coating weight on galvanized sheet for otherwise fixed conditions, it is desirable to know what influence the metals usually added to the galvanizing bath have on its viscosity. This led to a detailed study of the effect of small additions of aluminium, tin and lead on the viscosity, density and electrical conductivity of molten zinc. Similarly, the effects in tin of silver, copper, nickel and lead were studied. It was found that the small quanties of aluminium and other metals normally added to a galvanizing bath did not change the viscosity by an amount which would significantly affect the thickness of the coating formed. A much more interesting observation was made, however, in that minima in the viscosity/composition and density/composition curves occurred at concentrations closely corresponding to eutectics or limits of solid solubility([5]). So far no satisfactory theoretical explanation of these results has been obtained.

Hot-dip Aluminizing of Steel

A simple continuous hot-dip method of coating steel strip with aluminium has been developed in the laboratory([6]). Because aluminium coatings can withstand temperatures up to 700° C or more, aluminium-coated steel is suitable for use in many industrial processes that require temperatures too high for tin or zinc coatings([7]). Aluminium is generally resistant to corrosion, and if body members of motor and railway vehicles were to be coated with it they could be bonded to aluminium body sheet without placing dissimilar metals in contact. A troublesome source of corrosion could thus be removed and at the same time protection could be given against ordinary rusting. Aluminium-coated steel has good resistance to atmospheric exposure and could serve well for cladding buildings because of the combination of the high reflectivity of an aluminium surface and the strength of a steel base.

Several difficulties have been encountered in the past in the development of the hot-dip method of aluminizing. These have been largely due to the hard and brittle layer of iron-aluminium alloy that is formed on the steel surface. This layer limits the deformation that the coated sheet will withstand. Moreover, an oxide skin forms on the surface of the aluminium bath, and some of this oxide is picked up by the immersed steel, marring the surface. Various methods have been proposed for working with a molten flux blanket on the bath, as in galvanizing, but none of these has proved entirely satisfactory. The Sendzimir process has been successfully developed for hot-dip aluminizing by the A.R.M.C.O. Steel Corporation of America([8]), but the plant is costly and only suitable for production of coated sheet on a large scale, for which there is not yet a market in this country. The difficulty caused by the oxidation of the ingoing strip was overcome in the BISRA method by careful preparation of the surface, after which a film of glycerol was applied.

This avoided the use of a flux and made it possible for the strip to be passed into the aluminium bath through a protective box, which prevented the aluminium-oxide film reaching the strip. The burning of the glycerol on the surface of the aluminium discouraged oxidation of the aluminium surface and kept the strip free from oxidation before immersion. The growth of the iron-aluminium alloy is retarded by addition of a small amount of silicon to the aluminium bath.

This process was successfully worked with continuous strip up to 3 in. wide. It has the additional advantage that heavily cold-worked steel can be annealed as it is coated, which is often very convenient and an economic advantage.

The process has been applied by one firm for aluminizing steel wire. Its further application largely depends on development of the market for aluminized steel.

Further study of the properties of aluminized steel has shown it to have a particular advantage in its scaling resistance. For example, it has been

found that heating for up to 2,000 hours at a temperature of 700° C causes negligible growth of scale. When the coating contains silicon the aluminium surface loses little of its lustre at temperatures up to 550° C([7]).

Hot Tinning of Copper Wire

A process (which is being patented) is under development for tinning copper wire by drawing it through a die whose entry side is flooded with molten tin. By this means the wire can be coated without using any flux, provided that its surface is clean and freshly drawn. Uniform thin coatings about 40 micro-inches thick have been obtained with reductions in wire diameter of 5 per cent. to 10 per cent., and drawing speeds of the order of 100 ft. per min.

Recovery of Zinc from Galvanizing Dross

Some years ago the severe shortage of zinc was a strong incentive to save it. The large difference between the market prices of zinc and dross also encouraged the investigation of means of reclaiming zinc from dross. The metal sludge or dross which collects at the bottom of galvanizing pots can spoil the coating if it comes into contact with it, and the dross has consequently to be removed periodically from the pot. The dross contains about 97 per cent. zinc and 3 per cent. iron, and is thus of considerable value. A large proportion of the zinc is present as free zinc and is merely trapped in the dross, which is otherwise composed of an iron-zinc alloy. A novel method for recovering a large amount of the zinc from dross was developed at Sketty Hall([9]).

The process consists of adding the dross and some aluminium to a bath of lead and heating the whole melt to about 750° C. The iron combines with the aluminium and floats to the surface as an alloy, while the zinc dissolves in the lead. The iron-aluminium compound is skimmed off and the zinc-lead solution is allowed to cool to a temperature at which the zinc crystallizes out on top of the molten lead. The zinc is then removed as a solid block and the lead can be used again. By this process it is possible to recover 95 lb. of pure zinc from each hundredweight of dross.

This method of recovery is comparatively cheap and simple and can be used in any works([9]). It is particularly suitable for operation on a small scale, as might be required in a galvanizing works. The economic value of the process depends on the relative market values of zinc and dross.

The Use of Aluminium in Hot-dip Galvanizing

The addition of aluminium to the galvanizing bath to prevent alloy being formed in the coating is widely practised in Europe. In Britain and America only very small additions are usually made to increase the lustre of the coating.

Conflicting views have been expressed concerning the amount of aluminium to be added, and various explanations have been given for its effect. Although 0·15 to 0·30 per cent. was generally quoted, well-known workers stipulated 0·6 per cent. as the minimum amount to be added. Work by BISRA([10]) showed that for the temperature and times of immersion used in sheet and wire galvanizing, 0·10 per cent. aluminium could completely eliminate the alloy layer usually formed on mild steel. Pack-rolled sheet and strip could be bent to destruction without detaching the coating. Even 0·05 per cent. aluminium gave greatly improved bending results. Some alloy was formed with this amount of aluminium, leading to a somewhat thicker coating but without serious loss of formability.

An investigation of the results produced by addition of aluminium showed that some of the current explanations could not be true. By further increasing the amount of aluminium to, say, 0·7 per cent., it was shown that a new alloy layer, rich in aluminium, was formed which was far more adherent than the normal iron-zinc alloy, even when very thick. It was, therefore, suggested that the so-called "absence" of alloy, attributed to "inhibition" by aluminium, was really due to an exceedingly thin layer of this new alloy, not normally visible under the microscope.

The existence of such a thin layer was later confirmed by other British workers.

Study of the Properties of Coatings

The assessment of the virtues and shortcomings of existing coatings and study of the properties and uses of new ones is an essential part of the laboratories' activities. Intensive research into the mechanism of corrosive attack on a particular coating is sometimes necessary.

The Flaking of Hot-dipped Zinc Coatings

The formability of hot-dip galvanized sheet and wire is limited by flaking of the coating. This is usually attributed to the presence in the coating of a hard and brittle alloy layer. By adding aluminium to the galvanizing bath the alloy layer can be eliminated; the bending behaviour of the coating is then greatly improved, but its thickness and, therefore, its probable life, are correspondingly reduced.

This is not a complete explanation of flaking. The degree of flaking may vary over a single sheet when the thickness of alloy is constant. This is due to variation in the thickness of the outer zinc layer. In the galvanizing of wire, wiping off most of the outer layer of zinc improves the bending (wrapping) properties of the wire. When a hot-dip galvanized coating is completely converted to alloy, flaking does not occur.

(*continued in page* 294)

THE TREATMENT OF GASEOUS EFFLUENTS

Operation of the 'Oxycat' in Heat-Recovery Systems

By A. AIKENS *

THE provision of an adequate ventilation or extraction system for a finishing shop does not necessarily mean that the last word has been said with regard to air treatment.

The movement of large quantities of polluted air from the shop requires that it shall be replaced with an equal volume of fresh air which has to be warmed up to the ambient shop temperature. Thus, an exhaust system can result in considerable heat losses. Furthermore, the gaseous effluents can give rise to a significant degree of air pollution, a matter which is increasingly being deprecated by local authorities.

Methods of dealing with liquid effluent to avoid excessive pollution of natural waters or sewage systems have been the subject of much investigation, and are now well known and established. Atmospheric pollution on the other hand has only very much more recently been brought into the limelight so that the treatment of gaseous effluents has received comparatively little attention so far.

However, what is claimed as a major contribution towards a solution of the problems of rendering gaseous effluent innocuous has now been made available to industry through the medium of a new company—Oxy-Catalyst Sales Ltd. formed as a subsidiary company of the Vokes Ltd. Group in collaboration with the Oxy-Catalyst Co. The new company has been formed to introduce the Oxycat, an invention of E. J. Houdry, the originator of the petroleum cat-cracking process. As its name implies, the Oxycat is an oxidation catalyst which operates by catalyzing the low-temperature reaction between atmospheric oxygen and compounds of carbon, hydrogen and sulphur, the principle contaminants of gaseous effluents.

Essentially, the Oxycat, shown in Fig. 1, consists of 71 ceramic rods of streamlined section, coated with an activated film of alumina and platinum alloy. These rods are mounted between two ceramic end plates which are held together by a central rod. For certain specialized requirements the number and arrangement of the rods is varied.

Operation of the Oxycat

The method of operation of the Oxycat may be illustrated in terms of a simple example, *e.g.*, carbon

* Technical Director, Oxy-Catalyst Co. Ltd.

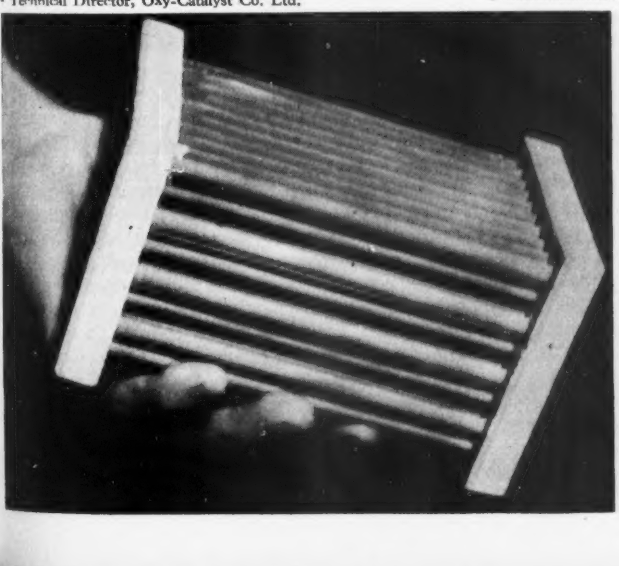


Fig. 1. A single Oxycat unit

monoxide, one of the constituents of towns gas. This is a highly poisonous and highly combustible gas which is explosive on ignition when mixed with air at all ratios between 12·5 and 74 per cent. by volume. Within the explosive mixture range a minimum temperature of 1,128° F must be reached before combustion will take place.

However, under the catalytic influence of an Oxycat any concentration of carbon monoxide, even below the lower explosive limit will react with oxygen at a temperature of about 500° F.

The reaction is not combustion as normally understood because there is no evidence of flame, but the molecules of carbon monoxide combine with their correct proportion of oxygen and give off heat which is proportional to the amount of carbon monoxide per unit volume.

Other combustible gases are dealt with in a similar manner, with, of course, different lower explosive limits and ignition temperatures.

Ammonia gas in passing through the catalyst bed at around 500° F breaks down into nitrogen and hydrogen, the nitrogen being inert and odourless, while, if oxygen is present the hydrogen is oxidized into water vapour.

Most objectionable industrial gaseous effluents contain combustible gases and it is usually these materials which cause the nuisance. Solid carbon particles which can be present as black smoke can be dealt with by the catalyst, but generally it requires a higher temperature at the catalyst to obtain oxidation of these materials depending somewhat on the particle size.

In order to start the catalyst reaction, the gas stream entering the catalyst must be heated up to a minimum temperature of 500° F. Once the reaction has started the catalyst temperature will increase until equilibrium has been reached. For example, as the gas comes in contact with the catalyst-coated stick, the stick temperature increases due to the exothermic reaction until the amount of heat generated equals the heat lost to the gas stream through heat exchange. Each successive row of catalyst sticks through the depth of the bed operates under different conditions. The first row comes in contact with the lower temperature of the gas and the higher concentration of burnables, so consequently, the extreme difference between the temperature of the catalyst and gases exist. As progress is made through the bed the catalyst sticks maintain practically a constant temperature. The gas stream approaches the catalyst temperature by absorbing heat from the hot sticks.

Most efficient catalytic operation takes place at catalytic temperatures over 1,200° F. At these temperatures complete combustion will take place, at lower temperature 90 to 100 per cent. complete combustion will result, depending upon the nature of the contaminating substances.

When unusual applications are to be dealt with, tests should be conducted to determine at what outlet temperature satisfactory elimination can be obtained. This outlet temperature should then be maintained at all times to ensure satisfactory operation of the installation. The outlet temperature has to be maintained through a combination of inlet temperature plus the temperature rise from the combustion of solvents or burnable materials. For example, if it is determined that an outlet temperature of 1,000° F is necessary to give satisfactory elimination of all odour, and through calculation it is found that the burnable material will give approximately 600° F temperature rise through the catalyst then an inlet temperature of 400° F will be required at all times. A calorific value of 1 B.T.U. per cubic foot of effluent will give a temperature rise of 50-55° F.

After catalytic oxidation has started at 500° F the catalyst will maintain combustion of even room temperature gases, provided there are sufficient combustibles in the gas to furnish the heat to keep the catalyst at reaction temperature. Standard procedure is to provide a preheat burner ahead of the catalyst, of sufficient size to heat up the gas flow to 500° F. A thermocouple placed at a suitable location after the catalyst bed can be wired to a controller to shut off the fuel supply valve to the burner, once the catalytic reaction has started and the temperature is rising. The preheat burner will continue to be shut off as long as sufficient burnable materials are passing to maintain the catalyst at the active temperature. If during the plant process work is halted and the burnable material ceases to be present in the exhaust gases, the temperature of the gases will drop and the control valve will open furnishing fuel to the burner to maintain the catalyst at reaction temperature.

Installation of the Oxycat

Installation of the Oxycat is relatively simple. The catalytic units are arranged in a bed, side by side, end to end, and stacked in two, three or four layers deep. Ceramic spacers are placed over and between layers of end plates in order to tie the units together into a stable bed and also prevent bypassing of the gases. This catalyst bed is usually supported on a "heat-resisting" steel grating, the size and weight depending on the size of the chamber, the load to be carried, and the method of supporting the grating. Insulating firebrick can be used to line the chamber around the catalyst bed. This lining should be of suitable composition and thickness to protect the steel housing from the high heat developed by the catalyst, and also retain as much heat as possible inside the chamber so that no cool spots can develop at the edge of the catalyst bed.

The size of the catalyst bed or the number of catalytic units required to satisfy a specific installa-

tion is a function of the quantity of gases to be handled and the relative concentration of contaminates. When the concentration of burnable materials is high, that is, when temperature rises through the catalyst range from 700° to 1,200° F, a space rate of 5 cu. ft. per min. per Oxycat should be used. If it is only a question of removing traces of gases, a space rate of 20 to 23 cu. ft. per min. can be used. The exact relationship will have to be determined in each individual case.

A preheat burner, or heat source will be required ahead of the catalyst to preheat the gases to 600° F to start the reaction if the exhaust gases are below this temperature. This burner should be controlled to shut off or throttle down when the catalyst reaches its operating temperature. In general, Oxycat installations can be divided into two general classifications.

Heat Generation and Recovery

When the concentration of burnable materials in the exhaust gases is high enough to result in an increase in temperature through the catalyst bed sufficient to justify recovery or use of the heat generated, the system can be worked out as a heat recovery unit.

In such a case, the exhaust from the oven or process is drawn through an exhaust blower and passed through the catalyst bed (*see* Fig. 2). The preheating unit is used to start the reaction and is controlled to throttle off after the reaction has started. The burner should be sized to heat the exhaust gases to 600° F entering the catalyst and the thermocouple control after the catalyst set at 800° F. This ensures complete catalyst activity and a good rate of reaction before the preheat is shut off.

The hot clean gases from the catalyst can be returned back to the oven or process, replacing the source of heat previously used to heat the hot air for the process. Applications such as paint baking ovens in the U.S.A. have recovered sufficient heat from the oxidation of the solvents in the paint to eliminate any outside source of heat entirely. This saves the owner his entire fuel bill for operating the ovens. However, experience in the U.K. has revealed that paint drying ovens operate with much larger quantities of exhaust air, and in consequence smaller concentration of solvent vapours than in the U.S.A. With the fuel position being so acute as it is in this country, there would appear to be an opportunity for oven manufacturers to design plant to take advantage of this potential economy.

In cases where the hot gases cannot be returned to the process, the heat can be used to generate steam or heat hot water or can even be returned or exhausted inside the building to heat the plant.

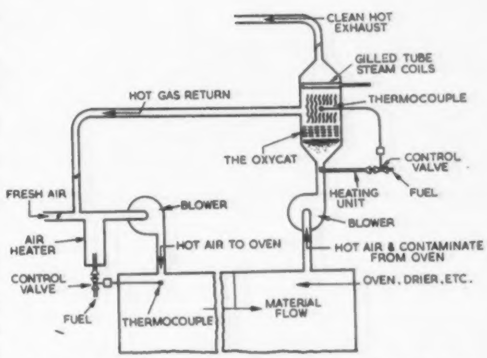


Fig. 2. Diagrammatic representation of methods of heat recovery by use of the Oxycat.

Elimination of Trace Contamination

Where an installation is to be used for the elimination of small traces of burnable material it is recommended that a heat exchanger be used to heat up the gases before they enter the catalyst bed, otherwise the cost of fuel would be so high that the operational cost of such an installation would be prohibitive. As an example, if pilot testing shows that a temperature of 750° F through the catalyst is required to eliminate all traces of fumes, the cold process exhaust gases can be passed through the tube side of the exchanger and preheated to 600° F so that only a small burner is needed to raise the temperature of the gases to 750° F to the catalyst.

Contamination of the Catalyst

Since the reaction of the catalyst is a surface reaction, any material present in a gas stream which tends to coat the catalyst, or form a deposit on the surface of the catalyst, is a contaminator. Contaminants, by gradual accumulation, eventually form a film on the surface and this film prevents the molecules of gas from coming into contact with the catalyst. When this condition occurs, there is no possibility of reaction.

A common cause for contamination is the presence of metallic oxides, such as lead oxide or iron oxide. Usually catalyst contamination can be detected by a decrease in the activity of the catalyst. Decreased activity is indicated when a catalyst becomes sluggish, such as taking a long time to reach operating temperature, and when a higher initial temperature is required to bring it to a state of activity. For example, if a catalyst normally starts to function after being brought to an initial temperature of 500° F it is possible that when it has decreased in activity it may not start to function until it has reached a temperature of 600° F.

(*Continued in page* 288)

OVERSEAS REVIEW

A Quarterly Survey of some of the Features in Finishing Literature from Abroad

by **SCRUTATOR**

PROBABLY the most important metal treatment news to "break" within the last few months is the release of information on the Hinac process—an American surface treatment for black plate which for some applications is claimed to be a substitute for tin plate.([1]) It was developed during the Korean War when in conjunction with the Bethlehem Steel Corporation and Heintz Manufacturing Company the American Can Company started its own "Operation Survival". The coating which consists chiefly of chromium compounds has good alkali resistance, and Hinac-treated steel is mainly used for the manufacture of containers for liquid detergents. The process is non-electrolytic and non-sludging, requires only a few seconds treatment time and is thus eminently suitable for strip line application. The line at the Bethlehem Steel Corporation was first started in August, 1954, and is now producing 100 tons per day principally for the American, Continental and National Can Companies respectively. A rapidly-increasing market for Hinac-treated material is forecast, particularly as the process is also applicable to magnesium, aluminium, zinc, copper, and stainless steel. The only technical information available is that the processing sequence comprises electrolytic clean, water rinse, activating rinse, water rinse, acid etch, water spray, brush and water spray, water spray, dip in the coating solution followed by roller coating, bake, cool and re-coil.

Phosphating

Although no striking new developments have been announced, our general information on this important section of the metal finishing field has been increased by three recent publications. In an article aptly entitled "Embrittlement (?) of phosphate steel", Weinberg and Capello([2]) have shown that using Federal Specification 4340 steel (0·4 per cent. C, 1·8 per cent. Ni, 0·83 per cent. Cr and 0·25 per cent. Mo) tempered for 1 hour at 400°, 600° or 870° F to give three different degrees of hardness, some evidence of embrittlement was found at the higher strengths using 2 zinc- and 1 manganese-phosphate process. This could be completely overcome by ageing for 24 hours at room temperature or heating for 1 hour at 220° F. Salt spray, water immersion and humidity test results by Heinzelman([3]) confirm established production experience that there is little difference between the corrosion protection of coatings from chlorate or nitrate-accelerated zinc phosphate baths. At worst they are equal but the finer grained lower coating weight coatings from the chlorate bath absorb less paint and show superior impact and bend test properties. Results are also presented to show that chlorate-accelerated zinc phosphate solutions show no undue attack on the plant and equipment which can be made of mild steel. Scale removal is one of the major maintenance problems associated with phosphating. Maintenance engineers will therefore be interested in a report([4]) that since the American Coolair Corporation installed a proprietary water conditioner at the point where the city water line entered the plant there has been no chiselling of tank walls or heating tubes. Further the existing scale became soft and could be washed away by a simple hosing operation. It is stated that in principle the water is passed through a mechanical force field created by Alnico permanent magnets. The theory, however—"the molecules of scale-forming substances receive a superficial tension due to electrical bombardment"—savours much more of sales than science!

Pickling

Acid etch milling is after all only controlled pickling and at North American Aviation, Columbus, Ohio, where hydrochloric acid is used as the production etchant for chem-milling aluminium, gaseous hydrogen chloride is introduced into the baths.([5]) This provides a simple, effective way of preparing and holding the acid concentration at any desired level. An etch rate of 0·001 in. per minute is used and plans have been made to etch 408 aluminium parts on a single aeroplane. Development work is in hand to extend the technique to alloy and stainless steels and titanium.

The addition of 1·5 per cent. sodium chloride to sulphuric acid pickling baths to function as an inhibitor in the pickling of special treatment and high-yield-strength steels was recommended last year by the U.S. Navy. By a modification of the Volhard method it is possible to determine the sodium chloride in 5 minutes.([6]) Other inhibitors, iron and impurities do not interfere.

(*Continued in page* 294)

Methods used in the performance TESTING OF PAINT

by
W. V. MOORE, B.A.

3. HARDNESS

(*Continued from page 246, June 1947*)

TESTS FOR HARDNESS

Scratch Testing

NEARLY everyone who has to deal with paint knows how to test it for hardness by scratching it with his finger-nail. Unfortunately, finger-nail toughness varies from person to person giving rise to wildly varying results, and there is a further disadvantage in that, after three or four scratches, it is very difficult to remember the order of hardness unless there are very wide differences. Obviously a much more rigorous test procedure is required.

A simple method giving more uniform results makes use of a series of ordinary lead pencils. The pencils vary in hardness from 4H to 4B and each pencil in turn is drawn across the paint film, the hardness being denoted by the grade of pencil which first penetrates the film. This system has the disadvantage that the final control of the hardness grade rests with the pencil manufacturer and may vary without notice, while there are other disadvantages which are inherent in all hand-operated tests. These are that the results obtained are dependent to a considerable extent upon: (1) the shape of the point used to scratch the surface; (2) the pressure applied to the point; (3) the angle of attack and the rate of motion of the point over the surface.

To obtain consistent results the conditions of the test must be much more closely controlled and this control is obtained in the mechanical scratch test apparatus. The apparatus which is described below is one of several which have been designed but in which the principle of operation remains the same.

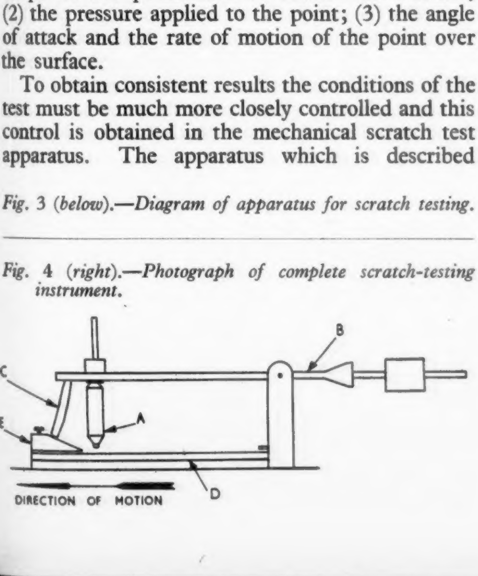
It consists essentially of a fixed needle which makes the scratch and a test-piece which is drawn along underneath it. Fig. 3 shows this part of the apparatus diagrammatically and Fig. 4 is a photograph of the complete instrument. In Fig. 3, A is the scratching needle. It consists of a small spherical steel ball, generally 1 mm. in diameter, soldered or brazed into a holder so that it is always normal to the test surface. The needle is held by the arm B, pivoted so that the needle can be raised from the surface and counter-poised so that it normally rests on the surface without any appreciable weight. Directly above A is a small platform for carrying weights so that any desired load can be carried. Immediately in front of A is a steel guide pin C whose purpose is to guide the scratch needle on to the test surface.

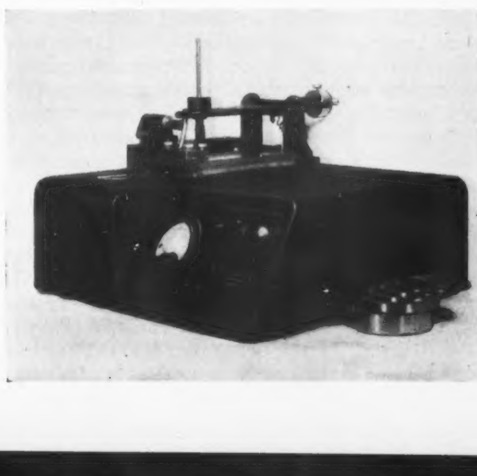
D is the moving table to which the test panel is clamped. It is controlled by an electric motor which drives it horizontally at a speed of 3-4 cm. per sec. The travel is adjusted to give a scratch of at least 6 cm. in length. After making a test the table is stopped automatically at the end of its travel and there is also a reversing switch to bring it back to its starting position.

The clamp which holds the test panel in position also helps to ensure that the approach of the needle to the test surface is the same in each test. This

Fig. 3 (below).—Diagram of apparatus for scratch testing.

Fig. 4 (right).—Photograph of complete scratch-testing instrument.





clamp (E in Fig. 3) is in the form of a ramp and in the start position the guide pin C is at the top of it so that the scratch needle is lifted clear of the test panel. When the table starts to move the ramp moves away from under the guide pin and the scratch needle is lowered on to the moving surface. It is found to be better to lower the needle on to a moving surface than to start from rest with the needle already on the surface. This is because the needle sometimes digs into the surface while at rest thus causing a deeper scratch to be made.

The operation of the machine is as follows: The steel needle is examined under a magnifying glass to make sure that it is not blemished or distorted. Damaged needles must always be replaced. The test panel is then clamped to the table and the guide needle placed at the top of the ramp. The required number of weights are placed on the load platform and the motor switched on. When the sliding table reaches the end of its travel the scratch needle is lifted from the painted surface and the motor reversed so that the panel returns to its original position. The test panel is then unclamped and the scratch on its surface examined. It is necessary to lift the scratch needle when reversing the panel to prevent it making a second scratch on the return journey.

Assessment of the paint in the scratch test is restricted to pass or failure. The paint is said to have passed the test if no sign of the substrate is visible along the scratch and failed if complete penetration of the film occurs. The load on the scratch test needle is noted and the paint is said to have passed or failed a test of so many grammes.

As well as showing scratch resistance, this test can also give further information about the paint. For instance, when examining the scratch, it will be found that a hard but brittle paint will tend to chip under the needle and small pieces will break away, while a paint that has not completely through dried will be drawn along with the needle and tend to clog it. Poor adhesion will also be shown by the paint lifting along the edges of the scratch.

In some instances it is difficult to judge precisely when the substrate is exposed especially when the paint is very near to failure. To overcome this the instrument may be fitted with a small electric light bulb with the scratch needle and painted panel forming part of the circuit. Since most paints are good insulators the lamp remains unlit while there is still paint between the needle and the panel but lights up as soon as penetration occurs. Thus failure to pass the test becomes immediately obvious.

The scratch test instrument measures a property of the paint film which, while scientifically ill-defined, is useful in a general assessment of the paint. The reproducibility of results is dependent upon the state of the needle and upon control of the thickness of the paint film applied. A thin film will fail before a thick film having the same scratch hardness. This is, of course, a disadvantage, but the difficulties involved in measuring the penetration of the surface warrants the continued use of the appearance of the substrate as a criterion of failure. Variations in hardness will also occur due to variations in drying time. Most paints show considerable increase in hardness in the period immediately after application when the film, although apparently dry, is still not fully oxidised or cured. Tests should therefore be carried out either at intervals of time to measure maximum hardness or after a fixed drying time.

Rocker Hardness

Scratch testing is not the only means by which the hardness of paints can be measured. Another commonly used method is that of measuring hardness by means of a rocker. In this method the paint surface provides a base on which the fulcrum of a pendulum rests. The rate at which the amplitude of the oscillations dies out depends upon the hardness of this surface and is used as a measure of it. Numerous instruments of this type have been designed and a well-known example is the Sward Rocker.

Fig. 5 shows a diagram of this instrument and Fig. 6 a photograph. It takes the form of a pair of circular rockers 4 in. in diameter and spaced 1 in. apart. A pendulum is pivoted at the top between them. It has a small pointer at its lower end which

Fig. 5 and Fig. 6.—Diagram and photograph of "rocker" hardness test equipment.

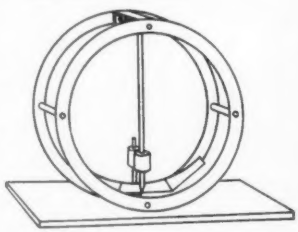
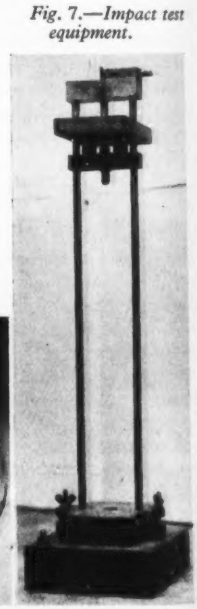


Fig. 7.—Impact test equipment.



moves over a scale and this is used to measure the amplitude of the oscillations. There is a stop at either side of the pendulum which prevents large oscillations.

There is one fixed point in the Sward hardness scale, the hardness of plate glass which is arbitrarily fixed at 100. The way in which this fixed point is obtained is as follows: The rocker is placed on a sheet of plate glass which has been levelled by any convenient means. It is rolled slowly to the left until the pendulum rests against the stop and then released. The oscillations made by the rocker are counted and the point reached by the pendulum after 50 oscillations is marked on the scale. This is the one fixed point, the hardness being obtained by multiplying the number of oscillations by two. Small variations may occur during the life of the instrument so that the number of oscillations made before the pendulum reaches the mark is no longer 50. This can be corrected by altering the position of a small weight which moves up and down a screwed post fixed behind the scale. Raising the weight reduces the number of swings, lowering it increases them.

When testing paint films, the paint is applied to a sheet of plate glass and allowed to dry. The rocker is placed in position as before and allowed to oscillate. The number of oscillations made between the time the pendulum just fails to touch the stop and the time it just fails to reach the mark on the scale are counted. This figure multiplied by two then gives the Sward hardness. In order to minimize the effect of draughts upon the instrument it is advisable to place a glass cover over it while measurements are being made.

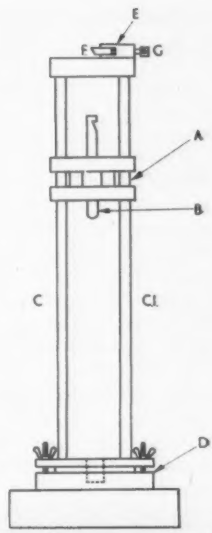
The instrument as described above is in its simplest form. Improvements have been made whereby the oscillations are started magnetically and counted photoelectrically but the principle of the instrument remains the same.

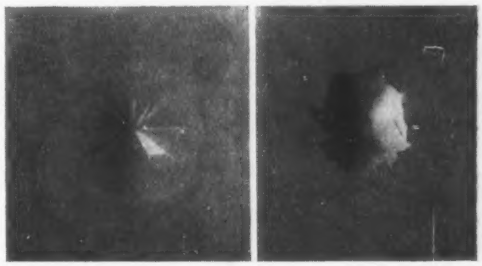
The Sward Rocker has the advantage of being a small portable instrument requiring only a level surface on which to work. It is also non-destructive so that the variation in hardness of a film upon ageing can easily be followed. It does, however, require a film with no surface imperfections such as brush marks or specks of dirt if it is to give reliable results. The necessity of preparing finishes on plate glass is also a great disadvantage when using stoving finishes with high stoving temperatures.

The two methods of measuring hardness described above are probably those most widely used. Other methods have been designed including indent tests similar to those for metals. But the high elasticity of paint films makes this rather a difficult procedure since the area of the indent must be measured while the indenter is still in position.

Fig. 8 (right).—Diagram of impact test apparatus.

Fig. 9 (below).—Two examples of results obtained with impact test apparatus.





The principle of the scleroscope has also been used but it would appear that in this case the nature of the substrate is likely to have a large effect upon the results.

Impact Testing

The resistance of a paint to sudden blows is of importance especially in the case of metal articles such as refrigerators and kitchen furniture where such blows are likely to be part of the normal wear and tear. In order to test this resistance painted panels are subjected to a standard impact delivered by a hammer and the resulting indentation studied for break-down of the paint film. No actual physical measurement is made but the effect upon the film enables paints to be differentiated.

A typical impact tester is shown in Figs. 7 and 8, the blow being delivered by a hammer weighing 10½ lb., which falls freely under gravity for a distance of 22½ in. In the diagram A is the hammer whose striking edge B is a hemisphere of ½ in. diameter. C, C1 are guide rails which ensure that

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Performance Testing of Paint

(*continued from page* 287)

the hammer falls directly on to the panel clamped in the vice D. E is a releasing device for the hammer.

The vice D consists of two heavy steel plates between which the painted test panel is inserted. To prevent movement of the panel during the test the plates are bolted together. The hammer blow is struck through a circular hole drilled in the upper plate, while a similar hole in the lower plate allows for deformation under the blow. The releasing device E consists of a spring-loaded tongue F, which fits into a notch in the upper portion of the hammer. F can be withdrawn by pulling the handle G, thus releasing the hammer.

To make an impact test the hammer is raised and the test panel clamped into position. The hammer is then released, following which the paint surface is examined. The weight of the hammer and the distance through which it falls are such that a small dome appears in aluminium or thin steel panels subjected to this test, and it is the appearance of the paint in this area which decides the result. In a paint showing excellent impact resistance there will be no visible difference between the paint on the distorted area and the paint on the undisturbed portion. Also there will be no tendency to flake off or decreased scratch resistance. On the other hand, poor flexibility and adhesion will be shown by splits in the film and detachment from the metal. The paint may flake away completely or remain round the centre of the dome rather like the petals of a flower in bud. With poor flexibility but increasing adhesion cracks will appear in the film but the film itself will not become detached. The ease with which the cracked film can be scratched from the surface will give an indication of the adhesion. The way in which the film breaks up depends upon the type of finish being tested. Some paints produce wide fissures with fairly wide areas of unbroken paint in between while with others the surface is broken up into very small areas by narrow cracks giving an impression of a crocodile skin on a small scale. Finally, with increasing resistance the film may not actually become broken but fine strain lines will appear on its surface and it will tend to have a lower scratch resistance.

There seems to be some difference of opinion as to whether this test should be conducted with the painted surface receiving the hammer blow or whether the blow should come from behind. But since the object of the test is to obtain as much information as possible it would seem that the best solution is to do the test both ways.

This type of impact tester is only one of many which have been used. Others give repeated blows or blows at glancing angles with hammers of various shapes and sizes, but the aim is always to study the effect of blows upon a paint film.

A test which applies the same type of deformation as the impact test, but in slow motion, is the Erichsen cupping test. In this test the hammer is moved slowly forward by a hand operated screw and the surface of the deformed panel examined as before. Alternatively, the surface may be watched during deformation and the motion of the hammer arrested as soon as breakdown of the paint occurs. The distance moved by the hammer gives a measure of the resistance to deformation.

Treatment of Gaseous Effluents

(*Continued from page* 283)

When a catalyst has become contaminated to a degree where it will no longer operate satisfactorily, it can usually be reactivated by means of an acid bath, if the contamination is caused by metallic vapours and oxides. It is also possible that the contamination is due to a coating of organic matter, such as accumulation of carbon or heavy hydrocarbons which vapourize at high temperatures. This type of contamination can easily be remedied by merely burning the carbon or hydrocarbons off the catalyst. Other causes for losing catalyst activity are temperatures in excess of 1,800° F and abrasion.

If a catalyst is subjected to these conditions a new catalyst coating will be necessary.

The catalyst is most effective on fumes which can be oxidized to carbon dioxide or water or both. These fumes include hydrogen, carbon monoxide and hydrocarbons in general. The catalyst is also effective on organic sulphides, chlorides, bromides and the organic nitrogen compounds. These reactions, however, involve other problems, such as the formation of acids or other compounds which may be odorous and undesirable. In many cases these undesirable products of oxidation can be controlled easily by water scrubbers, which are commonly used in the chemical industry.

Applications of the Oxycat

Catalytic oxidation can find application in a wide range of industries which give rise to gaseous effluents containing combustible gases or vapours. These include stove enamelling and lithography, paint application by spraying, dipping or flow coating, and core drying. It cannot, for obvious reasons, be applied to the elimination of acid fumes arising from pickling or chromium plating, where the effluent vapours are non-combustible.

A number of Oxycat installations are working in this country and at least one large Continental car manufacturer uses the system for treatment of paint shop effluent.

Production and Applications of ALUMINIUM POWDERS AND PASTES

An Account of Practice at the Louisville, Kentucky, works of REYNOLDS METALS CO.

Development of Aluminium Powders

THE use of thin metal foil or "leaf" for decoration and ornamentation dates back to early Egyptian days when the art of overlaying wood, bone and other materials with gold or bronze was developed. Through the ages this art spread through China, India and, later, Europe. Its height perhaps was reached in the fabulous extravagance of Louis XIV in whose court the glitter of gold leaf reached world renown.

Gold particles were melted, cast into bars, hammered down into thin sheets. These were reduced still further in thickness by interleaving with goldbeaters' skins and pounding the pack with a heavy hammer, producing leaf only a few millionths of an inch in thickness. In beating to thin leaf, certain particles broke off at the edges of the leaf. The artisan soon found, however, that these particles could be stuck together with egg white or other materials to look like a continuous leaf. The next step was to use such particles to form a paint for ornamenting chinaware, porcelain-enamelled objects and similar work.

Leaf scraps were then shredded by rubbing through a fine mesh screen to form a powder that could be utilized in paints. However, such powder was expensive, so similar powders were made from copper and bronze. Eventually base-metal alloys, coloured by thermal treatment, were developed to duplicate an almost unlimited range of tints.

"Silver bronze" powder was made either from tin or silver, but the manufacture of powder from tin involved certain difficulties, while silver was expensive.

Thus the advent of aluminium powder in about 1890 resulted in its rapid adoption by the bronze powder industry. This pigment was called "aluminium bronze" even though not made from a bronze alloy. Modern "aluminium-bronze" pigments are made from high purity aluminium.

Thus this reference to "bronze" has been carried down into today's usage by the metal-powder industry and is sometimes confusing to those not familiar with this historical background.

Early Production Methods

Possibly the first metal powder was made by hammering scraps of gold leaf or by grinding it in a mortar and pestle. Rubbing scraps of gold leaf through a fine-mesh wire sieve perhaps was next employed. These tedious manual methods of the goldbeater, however, were replaced by mechanical methods around the middle of the 19th century to give birth to the modern bronze powder art.

Today mechanical stamps or ball mills reduce the aluminium to powder. In the ball mills a charge consists of aluminium powder and steel balls. Aluminium powder is also made by atomizing molten aluminium and allowing the molten spray to harden in a blast of air.

Fig. 1.—Bridge and outdoor steel structures utilize aluminium paints for maximum visibility and resistance to corrosion. Their self-protecting characteristics also increase life of the paint itself, and thus further reduce repainting costs.

Fig. 2.—Shredded aluminium foil has been annealed and oil burned off; is ready to feed to first hammer mill for reduction into powder.

Early Applications

Until the latter part of the 19th century, the cost of metal powders limited their use largely to decoration and ornamentation of jewellery, chinaware, porcelain-enamelled work and objets d'art, but with the development of the bronze-powder industry and the resulting greatly reduced cost of the powders, application expanded rapidly.

A very fine powder was developed for striping or "lining" coaches and other vehicles. (The term "lining", referring to fine powders, is a carryover from this period.) However, "fine" powders of the older days were only 120 to 140 mesh. Now it is possible to produce powders so fine that 99·99 per cent. of a given sample will pass through a 400-mesh screen. But official reports today are based on the quantity passing through a 325-mesh screen as this is the finest screen certified by the U.S. Bureau of Standards. The finest powders are usually furnished in paste form (mixed with sufficient liquid to form a paste), since the extra-fine powders are easier to handle and use in this form.

Fig. 3.—These hammer mills take shredded foil and produce coarse powder from it. Note drive shaft turning series of cams operating hammers.

Types of Powders

Aluminium powders can be divided into two broad classifications—flake and granulated. The length or width of a flake particle may be several hundred times its thickness, whereas the length, width and thickness of a granulated particle are all of approximately the same order, the length probably not exceeding two or three times the thickness. Flake particles are thus essentially flat, while granulated are more or less spherical or "sausage"-shaped.

MODERN PRODUCTION METHODS

The first major advance in production methods came with the substitution of mechanical means for the laborious handwork of the goldbeater. Sir

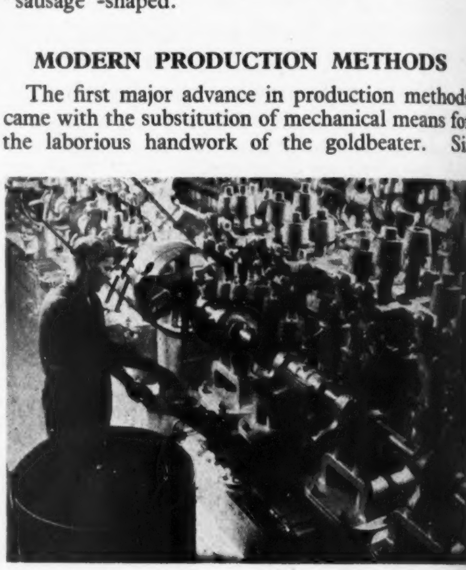

Fig. 4.—In these machines, cams raise and let fall a series of hammers that break up and reduce the size of the aluminium particles soom to become powder.

Henry Bessemer was so intrigued by the possibility of making a profit of nearly 25 dollars per pound by converting brass to "gold" bronze powder that, after concentrating on the problem for several years, he finally developed a satisfactory mechanical production method and profited greatly therefrom. In fact, he dominated the market for many years.

While the problem of producing fine particles of metal mechanically is not difficult, it is not so easy to give them the shape, brilliance and other characteristics required. The powder particles must be flat, have smooth surfaces, be separated from each other and have surface characteristics that permit one particle to slide over another easily. Also the colour must be correct.

All these characteristics necessitate the provision of certain features in the production methods. The best quality powder appears to be that produced by a large number of light hammer blows, affording the metal an opportunity to spread out, break off, work harden, etc.

Today, three different methods of producing aluminium powders are in use at the Louisville plant of the Reynolds Metals Company—the largest plant of its type in the world. Flake powders for chemicals and explosives are produced dry by stamping or hammering extremely thin aluminium foil. Pigment powders are produced as a paste by ball-milling granular powders in a liquid, and subsequent drying. Granular powder is produced by atomizing molten aluminium. Each method produces a powder with individual characteristics.

In addition to these, there are other methods of producing aluminium in finely divided form. "Grained" aluminium consisting of rough irregular particles 1/64 to 1/4 in. in length results when molten aluminium is stirred while it is solidifying. "Granulated aluminium" in the form of flattened

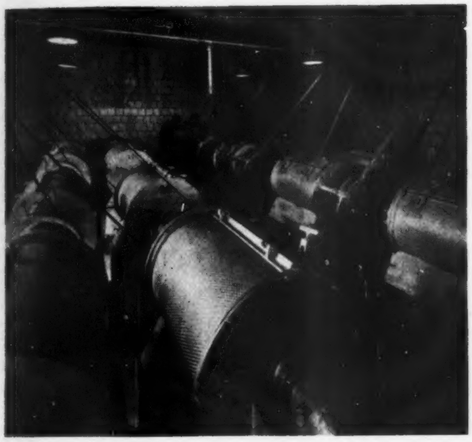

Fig. 5.—Polishing rooms where hammered flake powder is polished by bristle brushes in series of drums to produce surface colour and other characteristics.

drops up to 1/2 in. in diameter are made by pouring molten aluminium through a sieve into water. Shot is made in the same manner. The small particles resulting from grinding and sawing operations also have certain uses.

Atomizing

In general, granular powder produced at the company is made by atomization. Pig aluminium is melted in a furnace and as the molten aluminium flows through a small orifice in the atomizing head, it strikes a stream of air, which breaks up the liquid aluminium into many small particles to form a spray which is directed into a receiver. There it solidifies or freezes to form fine particles, roughly teardrop or spherical in shape. These particles then are blown on through a duct to a structure housing a series of canvas bags in which the granular aluminium powder is collected.

Fig. 6.—Measuring out the correct amount of powder for use in a mesh-fineness test, made by sifting powder down through set of screens in a mechanically driven device shown just to left of operator.

Stamping

Whereas production of powder by atomizing is a fairly simple process involving essentially a single operation, producing flake powder by stamping requires a number of operations. The particle size in atomizing is controlled by air and metal temperatures and by spray-nozzle adjustment. In stamping, many more factors arise, *e.g.*, thickness of original foil material; number, force and rapidity of the individual hammer blows; number of hammering stages employed; type and amount of lubricant; arrangement of air agitation and discharge; amount of polishing; etc. In addition the number and selection of screening operations between hammering

Fig. 7.—Aluminium powder is classified by screening through units such as this. Note spouts and screens are covered to prevent powder entering the air.

stages greatly affect the final product. It is these wide variations in the manufacturing process that are employed in producing the many types of powder to provide exactly the characteristics most suitable for each particular application in the chemical or explosive field.

Raw material for stamped flake powder is largely in the form of foil from the company's foil plants. The foil must be free from oil, grease, dirt, iron or other substances. Aluminium alloys cannot be processed because they do not reduce properly under the hammers, due to their high mechanical properties.

In order to remove the effect of work hardening during rolling and to make the material as workable as possible, the foil is first cleaned and annealed, then cut up into particles small enough to pass through a screen with ⅜-in. openings. Further reduction is by hammering in stamping mills which are of several different types. All have multiple hammers, raised by cams, which are allowed to fall to strike the steel anvil under gravity. The anvil and the lower end of the hammers are enclosed to confine the powder. Material is fed into the mill at frequent intervals while the discharge, which is continuous, must pass through a 20-mesh screen.

Lubricant is necessary to prevent the small particles from welding together under the impacts from the hammers. Lubrication also facilitates spreading of the metal under impact, thus increasing the rate at which large flakes are broken up into small flakes. Stearic acid is commonly used, although tallow, olive oil, rape oil or other oils may be employed.

The action of the hammers in beating out the metal into thinner and thinner flakes causes work hardening or embrittlement and so assists breakup. At the same time, hammering one flake over the edge of another produces a shearing action that further aids reduction of particle size.

Mills in the third stage usually employ more hammers, operate faster, produce a greater number of lighter blows than the second group of machines. All mills are in banks. These, like the other mills, are charged at regular intervals with the discharge being continuous. Fourth and fifth stages may be utilized for certain types of product, although particles from this third stage will pass through 40- to 300-mesh screens, depending upon length of time in the mill. Any particular powder rarely has all particles of the same size, unless specially made. Most powders contain a certain amount of fines of a certain size range, with some larger particles.

Grading

Grading to size, which is an essential step in production, is effected by screening through silk bolting cloth or wire sieves. A typical screen is of 100-mesh silk with a working area about 3 ft. x 7 ft.

Fig. 8.—Paste produced in ball mills is put through filter presses to produce filter cake shown. Further drying is done in special equipment under a vacuum to produce powder.

Cloth spouts and covers are employed to prevent the fine powders from becoming suspended in the air in the shop. Material not passing through the screen is taken back to the hammer mills and reworked. Various sequences of hammering and screening may be employed and tests for size and quality, etc., are made at every stage of manufacture.

Polishing

For many applications where a brilliant characteristic is desired, the flakes are polished by revolving brushes in a stationary drum.

The action during polishing is threefold. First a lubricant is applied to the surfaces of each flake particle. Then the rubbing action develops heat which softens the lubricant or polishing agent (usually stearic acid) and also helps to distribute it over the surface of the flake in extremely thin and uniform layers. Third, rubbing the flakes between the brush tip and inner wall of the drum flattens and smooths out the flakes.

Wet Ball Milling

The majority of all aluminium pastes and some powders are produced in ball mills. High-purity atomized aluminium powder is normally used as the raw material; it is charged into a large cylindrical drum along with a lubricant, a suitable liquid and a quantity of steel balls. The drum is placed with its axis in a horizontal position and revolved and by adjusting the speed of rotation, size and number of balls as well as amount of aluminium charged into the drum, it is possible to produce an operating condition where the balls "cascade" to provide a large number of hammer-like impacts as they fall against the inner wall of the drum.

This action closely simulates the hammering in the stamping mills, a desirable feature since hammering produces a high-quality powder charac-

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FINISHING POST

A SELECTION OF READERS' VIEWS COMMENTS AND QUERIES ON METAL FINISHING SUBJECTS . . . . .

Continuous Plating of Strip by the Tainton Process—a Corrected View

Dear Sir,

The April issue of your Journal reviews the discussion following presentation to the Institute of Metal Finishing of a paper on "Peen Plating", and one of the statements leaves an impression we should like to correct.

We quote from page 154:

". . . The Chairman (Mr. A. W. Wallbank) said that the peen plating process was developed by Eric Clayton and Ralph Pottberg, of Baltimore, the nephews of Tainton, the man who tried to persuade steelmakers in this country to adopt his process for the continuous zinc plating of strip from the ore."

The facts surrounding the circumstances of Tainton's advancement of his continuous zinc plating methods in England are perhaps most succintly set forth in "A History of the Wire Rope Industry of Great Britain" written for the Federation of Wire Rope Manufacturers of Great Britain by E. R. Forestier-Walker in 1952. I quote from page 144:

". . . shortly after these events, British Ropes were responsible for one of the more important technical advances of recent times. A long standing problem in the industry had been the loss of mechanical strength due to galvanizing, and Herbert Smith decided to investigate the process of electro-galvanizing employed by the Bethlehem Steel Company in America. On his first visit he was impressed, but was not entirely satisfied that the very high first cost would be justified. However, he paid a second visit in 1936 which convinced him that the adoption of this process would be well worthwhile and, as it so happened, on the outward voyage, he encountered Geoffrey Rylands of Rylands Brothers, who was making the journey with the same object in view.

"Herbert Smith had succeeded in getting first option to operate the process in England, but after the two men had discussed the matter, they agreed that it would be to their mutual advantage to purchase the British rights jointly, and install a plant each. They therefore proceeded on these lines, and decided that, in order to have the laying down of the plant properly supervised, and the initial team of skilled workers adequately trained, the inventor of the process, Tainton, should come over to this country. The cost of the patent right was about £60,000 and Tainton was paid some £10,000 expenses for the year or more he spent in England.

"The agreement between British Ropes and Rylands provided that they may jointly allow other companies to use the process under license; but it would seem that at today's prices, few, if any other concerns could afford to equip themselves with a similar plant."

Tainton and his industrial collaborators were naturally interested in and speculated about the applicability to other continuous shapes including strip, but this was the subject of only incidental work.

With the above facts in view you will understand our feeling that your summary of the technical background of the present development is somewhat fragmentary and could hardly fail to give your readers a wrong impression.

We recognize the possibility that it may simply have been selected out of context by a reporter unfamiliar with what is now "ancient history"; but we would naturally be grateful if you should find it possible to spare the space for this correction in a future issue.

Sincerely yours,

ROLFE POTTBERG.

The Tainton Company, Baltimore, U.S.A.

Plating Plant for India

Dear Sir,

We have undertaken the large-scale manufacture in India of snap fasteners (press buttons), and our senior partner, Mr. A. P. Jain, will be visiting Europe during July and August to arrange for the purchase of the necessary plant and materials for a daily production of 3,500 gross of these items.

Among other equipment required will be electroplating plant for this installation, and we would be grateful if those of your readers interested in supplying this would communicate with us as under:

Mr. A. P. Jain, c/o Wagens Lits/Cook, Hotel Breidenbacher Hof, Konigsallee 11, Dusseldorf, Germany.

Yours faithfully,

BISHAMBER DASS AND SONS.

Chandni Chowk, Delhi, 6, India.

Sketty Hall Laboratories

(*continued from page* 280)

A study of flaking[11] showed that a thick outer layer, by its rigidity, is able to pull the alloy layer away from the steel surface, the alloy clinging to the underside of the flake as a broken layer. An exception to this is the alloy formed on silicon-killed steel wire treated by the Crapo process.

Flaking may thus be prevented, or greatly reduced, by adding aluminium to the galvanizing bath, or by reducing the thickness of the outer layer of zinc. The second method has been found to apply also to hot-dipped aluminium coatings.

Instruments and Inspection Techniques

Investigations have been made into techniques and apparatus for the study of coatings. For example, a variety of magnetic and electromagnetic non-destructive coating thickness gauges were studied and the best operating conditions established[12]. An X-ray fluorescent tin-coating thickness gauge was developed[3], as stated earlier, and its performance examined, and further developments are planned in the use of radioactive isotopes.

Methods of examining the porosity of tinplate have been studied[13] and a new auto-radiograph technique has been proposed using radioactive cobalt.

Much work has still to be done on the development of continuous inspection techniques for in-line monitoring of the quality of coated products. Suitable techniques must be developed for use in the industry so that more comprehensive automatic control systems can be applied to coating processes and the way prepared for automation. A problem of particular interest is the inspection of tinplate for surface quality, for which a suitable objective and continuous method is much needed.

We are indebted to Mr. S. S. Carlisle, director of the Sketty Hall Laboratories, for providing much of the information contained in this description, and to Mr. W. Bullough for the description of the "Plasteel" process.

References

(1) "Gas Pickling of Steel", Pearson, J., Ph.D., M.Sc., F.R.I.C., Bullough, W., B.Sc., A.R.I.C., and Canning, T. A. *Journal of the Iron and Steel Institute*, June, 1950, pp. 185-190.
(2) "An Electron Diffraction Investigation of the Structure of Electrodeposited Coatings on Iron Single Crystals", Evans, D. J., M.Sc., A.Inst.P., and Hopkins, M. R., M.Sc., F.Inst.P. *Journal of the Electrodepositors' Technical Society*, 1952, **28**, 229.
(3) "An X-Ray Method for Measuring the Thickness of Tin Coatings". BISRA Summary 102. Paper submitted for publication in the *Journal of the Iron and Steel Institute*.
(4) "Electrodeposition of Iron-Zinc Alloys", Salt, F. W., B.Sc., Ph.D., Meecham, Miss S., M.Sc., and Jepson, S. *Trans. Inst. Metal Finishing*, 1955, **32**, 160.
(5) "Physical Properties of Certain Liquid Binary Alloys of Tin and Zinc", Toye, T. C., B.Sc., A.Inst.P., and Jones, Miss E. R. Submitted for publication in *Proc. Phys. Soc.*
(6) "Hot Dip Aluminizing", Hughes, M. L., Ph.D., M.Sc., F.R.I.C., F.I.M., and Moses, D. P., B.Sc., A.I.M. *Metallurgia*, September, 1953, pp. 105-122.
(7) "Hot Dip Aluminized Steel, Its Preparation Properties and Uses", Hughes, M. L., Ph.D., M.Sc., F.R.I.C., F.I.M. *Sheet Metal Industries*, February, 1956, pp. 87-98.
(8) U.S. Patent No. 2406245. 1946.
(9) "The Recovery of Zinc from Galvanizers' Dross", Hughes, M. L., Ph.D., M.Sc., F.R.I.C., F.I.M., and Humphreys, R. H., A.I.M. *Sheet Metal Industries*, November, 1953, pp. 955-966, 968.
(10) "Influence of Aluminium on the Alloying Action in Hot Dip Galvanizing", Hughes, M. L., Ph.D., M.Sc., F.R.I.C., F.I.M. Presented at International Conference on Hot Dip Galvanizing, Copenhagen, 1950. Published, Z.D.A., Oxford, 1951.
(11) "The Flaking of Hot Dipped Zinc Coatings", Hughes, M. L., Ph.D., M.Sc., F.R.I.C., F.I.M. Second International Conference on Hot Dip Galvanizing, Düsseldorf, 1952. Published Z.D.A., Oxford, 1953.
(12) "A Note on Magnetic Tests for the Measurement of Coating Thickness", Unpublished BISRA Paper MW/C/13/49, Hughes, M. L., Ph.D., M.Sc., F.R.I.C., F.I.M.; "A Supplementary Note on Magnetic Tests for Coating Thickness—The Elcometer", Unpublished BISRA Paper MW/C/56/51, Hughes, M. L., Ph.D., M.Sc., F.R.I.C., F.I.M., and Humphreys, R. H., A.I.M.
(13) "Examination of the Thiocyanate Porosity Test for Tinplate", Pearson, J., Ph.D., M.Sc., F.R.I.C., and Bullough, W., B.Sc., A.R.I.C. *Journal of the Iron and Steel Institute*, December, 1948, p. 376.

Overseas Review

(*Continued from page* 284)

Testing

Two new analytical procedures have been described which should ease the life of analysts in the electroplating industry. First, Leftin[7] has given details of an improved procedure for the photometric determination of molybdenum in zinc cyanide plating solutions which is rapid, accurate and on which a saving in time of approximately 15 minutes per determination can be realized. Second, Downey[8] has shown that the estimation of copper by the production of a yellow complex by reaction of cuprous copper with 2-9 dimethyl 1-10 phenanthroline can be applied to the determination of copper in nickel-plating solutions. Advantages for the technique are that the reagents are stable, the procedure is specific and simple, the method is sensitive and accurate, and because the coloured complex is stable, the absorbance need not be determined immediately.

No one envies the lot of the engineer who has to decide upon or select the best paint or protective coating for service in the factory, plating shop or for specific chemical exposure conditions. To help him, Richardson[9] has devised a screening test which will serve as a uniform basis for quickly weeding out materials with an inadequate degree of chemical resistance. Briefly this involves immersion for seven days in 10 per cent. aqueous solutions of nitric acid, hydrochloric acid, copper sulphate, sodium hydroxide or ammonium hydroxide; 5 per cent. sodium hypochlorite; and various organic liquids such as ethyl alcohol, kerosene, etc.

References

(1) *Iron Age*, 1957, **179** (23), 106-108.
(2) *Metal Progress*, 1957, **71** (4), 78-81.
(3) *Metal Finishing*, 1957, **55** (5), 61-64.
(4) *Iron Age*, 1957, **179** (18), 99.
(5) *Ibid*, 1957, **179** (20), 114-115.
(6) *Ibid*, 1957, **179** (23), 105.
(7) *Plating*, 1957, **44** (4), 380-382.
(8) *Ibid*, 1957, **44** (4), 383-385.
(6) *Organic Finishing*, 1957, **18** (3), 14-15.

The Development of VITREOUS ENAMEL AS A BUILDING MATERIAL in the U.S.A.

by EDWARD MACKASEK, Fellow of the American Ceramic Society

With the rapid increase in the use of vitreous enamel for architectural applications, special problems related to building construction service have arisen, the solution of which requires co-operation between architect, builder and vitreous enameller. To meet this need the recently formed Vitreous Enamel Development Council has established an Architectural Division. One of the first acts of the Division was to stage a meeting, attended by numerous representatives of the architectural profession, at which technical aspects of the use of vitreous enamel for architectural purposes were discussed. Reproduced below is a considerably condensed abstract of one of the papers presented at this meeting.

SINCE its introduction into the building field in the U.S. about 1930 the use of vitreous enamel has progressed rapidly so that it is now regarded as a standard building material. In the period of the great depression when sales volume in most industries sank to an unbelievable low, the vitreous-enamel industry moved ahead rapidly and particularly in the architectural field. The reason is quite obvious. The two factors vital to the maintenance and existence of every business were to cut costs, and to increase sales. In the building field vitreous enamel met both of these criteria. It cut costs by eliminating the periodic repainting necessary to keep a structure or a store front looking clean and inviting, and its durability made replacement of parts unnecessary. The attractiveness and design versatility attainable with vitreous enamel proved to have an eye-appeal to the consumer that boosted sales. It is a matter of record that the new types of vitreous-enamel petrol stations that came into being during this period increased gallonage sales over conventional structures by as much as 100 to 200 per cent.

Sales departments quickly recognized this fact and demanded vitreous enamel. In other words, architectural vitreous enamel was in this sense not only a building material for construction—it was also a material for building sales. And it still is! Many chain systems, such as the oil companies, tyre manufacturers and food stores, identify their outlets throughout the nation with distinctive colour schemes. One large restaurant chain has adopted as its slogan—"Stop at the orange roof"! There is no material, other than vitreous enamel, that is so effectively and efficiently adaptable to such service.

The war years gave an impressive demonstration of the inherent values of architectural vitreous enamel. Materials were unavailable, paint was scarce and labour unattainable. It was impossible to maintain smart appearance but these things did not bother those buildings with a facade of architectural vitreous enamel.

It was economic necessity that gave impetus to the development of the metal-clad wall or, as it is now generally called—the curtain wall. It was by no means a new concept as the curtain wall idea had been experimented with and discussed for many years past but there had been no real need for it up to now.

By using a curtain wall that may weigh 5 to 10 lb. per square foot as against a masonry exterior wall weighing 90 to 100 lb. per square foot, there will be a considerable reduction on the load on the structural elements and footings, with consequent savings in cost.

Such a saving was achieved by using a sandwich panel 1¼ in. thick for the construction of the Statler Hotel in Hartford, Conn., and when the Statler Hotel in Dallas was erected shortly afterwards, cantilevering the sandwich panels gave not only a further reduction in the amount of steel but also an improved layout that made possible a saving which amounted to more than $2,000 per room.

Economy in Cost

The raw materials required for the production of the components of a curtain wall are relatively more costly and the manufacturing processes more complicated and involved than for masonry. Any economy to be achieved through the use of curtain walls, therefore, will not result from a change of

materials. The favourable factors—mass production, manufacturing, factory assembly, space saving, better heat control, less weight, faster erection, higher rentals and lower financing costs—these all contribute to enhancing the desirability of curtain wall construction and making it an economically feasible construction. Although examples can be cited where they proved less costly, it cannot be stated as a general proposition that curtain wall construction will result in savings over conventional masonry construction. However, the wide acceptance by architects of this new system and the remarkable number of such structures that have been erected within recent years attest to the fact that cost is not necessarily the determining factor. Artistic appreciation, eye appeal, prestige and publicity value have a bearing. Public reaction has been most favourable. Considerable research is being underwritten to improve materials and to overcome difficulties. With greater production it is logical to assume costs will be lessened. Greater skills and wider experience on the part of building industry will simplify the field problems. It may be anticipated, therefore, that all the inherent advantages of thin metal walls will in time be fully realised as their use continues to grow.

There is an advantage in curtain wall construction for the builder also. More speedy erection will enable him to increase his volume of business and to get a more rapid turnover of labour and material, thus increasing his profits.

Materials

Vitreous (porcelain) enamel, stainless steel and aluminium have been the most widely used materials for curtain wall construction in the U.S. Bronze, plastics and glass have also been used but to a very small extent. Practically all buildings involving colour have used vitreous enamel infill panels.

Functions of the Curtain Wall Panel

As the principal unit of the wall surface, the functions of the curtain wall panel can be considered under a number of heads.

Visual Function

The wall surface must be uniform without visible distortion resulting from irregularities in the surface of the individual panel units. The inherent tendency for metal surfaces to deviate from a plane must be counteracted. It must be readily cleanable and of such a texture as to resist staining.

Structural Function

Although a curtain wall is by definition non-load bearing, it must have sufficient strength to carry its own weight and the weight of the sash, and also to resist wind pressure.

Thermal Function

The curtain wall panel must provide adequate insulation to prevent undue transfer of heat between the exterior and the interior of the building. The selection of a suitable core material to give the required insulation is one of the essential criteria in panel design.

Weather Function

The panel must be designed to be unaffected by weather and to exclude effectively the effects of all possible climatic conditions.

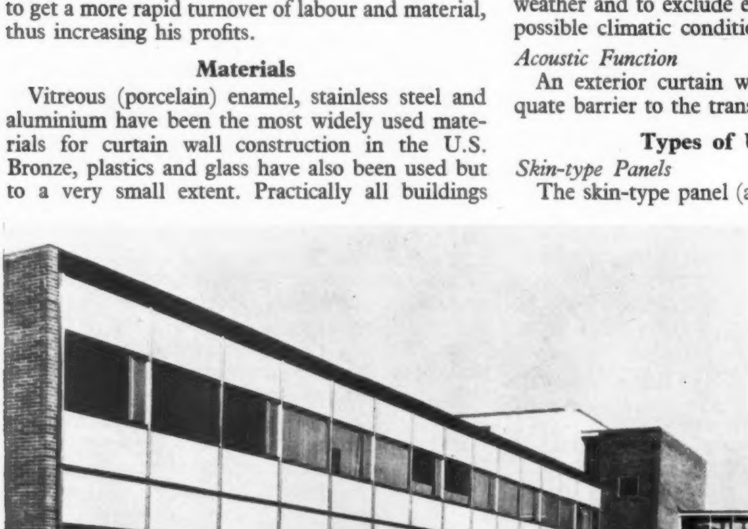
Acoustic Function

An exterior curtain wall must provide an adequate barrier to the transmission of sound.

Types of U.S. Panels

Skin-type Panels

The skin-type panel (also called the single-sheet



The new R.C.A. Victor office buildings in Camden, New Jersey, where the architect has used light coloured, long vertical-corrugated sheets of vitreous enamelled steel set in stainless-steel supporting frames.

panel) is used in composite wall construction. Here, the functions of the wall are performed by the two parts of which it is composed; namely, the skin and the back-up wall. The metal facing or skin is the decorative feature supplying the visual requirements; it also keeps out the rain, snow and wind. The back-up wall is the barrier against heat transmission and may serve also to resist fire. There is usually an air space between the metal skin and the back-up wall which contributes to the insulation value of the wall and may also serve as a ventilating stack to carry away moisture. The overall thickness of this type of wall is greater than for sandwich construction and therefore there is less available floor space. However, this construction must be used in locations where the building code requires that the exterior walls shall have a certified fire-rating.

Laminated Panels

A laminated panel is one in which the separate parts of the panel are bonded to each other by adhesives to form a solid, integral panel which acts structurally as a single unit. Actually, a laminated panel functions as a composite slab or beam so that a force applied against the panel produces stress not only in the metal facings but in each of the bonded components as well. In a laminated panel, therefore, the metal facings, the adhesive and the core material must each be capable of resisting, without failure, the stress to which it may be subjected.

The manufacture of laminated panels has been made possible by the great advances that have been made in the development of strong and durable adhesives. The stress developed in the usual curtain wall panel is not very large and many adhesives are now available to meet this service. However, evaluation of an adhesive for laminated porcelain enamel curtain wall panels must be based on considerations other than strength alone.

In the laminating procedure the porcelain enamel face is forced against the adhesive-coated core or backing material under pressure. Any surface irregularities in the panel are pressed out, resulting in a panel with perfect or near-perfect flatness. The bowing or "oil-canning", which, when present even to a small degree, is noticeable in unbacked metal panels, is eliminated in laminated panels and comprises one of the advantages of this method of assembly. Laminating presses usually have large beds capable of processing pieces up to five or six feet wide and twelve feet or more in length. Porcelain enamel laminated panels can be manufactured, therefore, in larger sizes than are practical for other types. Much thought and considerable research has been devoted to investigating the requirements for adhesives for use in the construction of curtain wall panels.

One of the most important properties of an adhesive suitable for curtain wall construction is that it has satisfactory ageing over a long period of time. Apart from being resistant to atmospheric influences, it must withstand a temperature range of —40 to 180° F. It must retain its strength when subjected to moisture whether resulting from condensation within the panel or from leakage through the joints. It must also be proof against loss of strength through vibration or small movements.

Laminated panels are of two types: those made with flat vitreous enamel sheets, and those made with vitreous enamel pans.

(1) *Flat Sheet Construction:* The use of flat sheets simplifies the problem of fabrication and facilitates laminating but exposes the full edge depth. The exterior sheet is vitreous enamel; the interior may be vitreous enamel, aluminium, painted metal, asbestos-board or other material. If the core material is hard or rigid, the vitreous enamel sheet may be laminated directly to it; however, if it is of soft material the vitreous enamel sheet must first be bonded to a rigid backing board.

Laminated Panels—Pan Construction: The flanges of this type of construction add to the rigidity of the facings and reduce the exposed area of the core. The gap between the edges of the flanges may be sealed by taps or a gasket. If the flanges overlap, they may be additionally fastened by metal screws, using a gasket between them to prevent metal-to-metal contact.

Mechanically Assembled Panels: In this type of construction a typical curtain wall unit is assembled by means of mechanical fasteners. The exterior face is a vitreous enamel pan; the interior is also pan shaped in vitreous enamel or galvanized metal suitable for painting. The flanges may overlap and be secured with sheet metal screws, using a gasket between them to prevent metal-to-metal contact; or if the parts do not overlap, they may be held together by lugs, using a tape to cover the gap between the flanges. The assembled exterior and interior pans form a box-type unit in which a variety of insulating materials may be used. In some panels, the exterior pan is filled with a poured light-weight concrete or gypsum backing to which the vitreous enamel is tied by welded studs or brackets to produce a flat surface, the filling also serving as insulation and as a sound deadener. The back pans are then usually filled with an efficient light-weight insulation material.

Other Factors in Panel Design

Effect of Climate

The wall should be designed to maintain proper differentials between temperature, wind velocity, moisture, dust and solar energy.

Resistance to Heat Flow

To maintain the considerable temperature differential that may exist at times between the interior and exterior of the building, the panel must incorporate insulation material with a high thermal resistance.

Effect of Temperature

Owing to the high cofficient of expansion of metals assembled panels will be subject to temperature stresses. In order to prevent warping and distortion suitable joints must be provided to accommodate movement. Furthermore, provision should be made for venting of sealed panels to avoid bulging owing to expansion of entrapped air. Metallic contacts between panel faces should be avoided as these can have a thermal by-passing effect which considerably reduces the insulation value of the panel.

Effect of Panel Colour

The difference in reflective and absorbtive properties of light and dark panels should be taken into account when designing panels for use in extreme climatic conditions.

Joint Design

Every joint between panels or wall units is a potentially weak point for the eventual penetration of water and air. The best method of designing a joint is first, to make it as weathertight as is humanly possible and second, to assume that it will nevertheless leak, and provide positive means for conducting the moisture out of the wall. This latter can be accomplished by an internal drainage system, or by internal ventilation to carry the moisture off by evaporation and weep holes to permit the moisture to escape to the outside.

Joints may be made watertight by the sealing action of plastic gaskets, by interlocking or spring action in the joint itself, or by the periodic application of caulking compounds. The joint must be flexible to provide for the large tolerances that occur in the field. It should also provide a tortuous path for the wind and rain, causing it to be dissipated before reaching the interior surface.

Test Methods

Many different types of component parts used in the construction of vitreous enamel sandwich panels are available to the designer and the manufacturer. To select the product that has the proper characteristics to meet performance requirements of the service it is important to know what its properties are and how they can be evaluated and specified. Standard tests are devised for this purpose. In general, the major advantage of standard test methods lies in the fact that they have been designed to give maximum precision and reproducibility in measurement so that an entire industry and its customers will not only be talking the same language but will also be assured that measurements made in widely separate laboratories by different personnel will be comparable.

To be successful, industry-wide methods must meet certain primary qualifications. First, the test method must measure the physical characteristics or property desired. Second, the precision of the method must be sufficient to produce the desired results in any single laboratory not only in a single test but in repetitive tests and it must be capable of producing comparable results between different laboratories. Third, a standard test method should be as simple and as rapid as it is possible to make it in order to hold the cost of equipment and operation at a practical level and to give the desired results in a minimum of time with a minimum of effort.

These three primary qualifications for the development of a good standard test method may at first glance appear relatively simple, but actually the problem is not as simple as it would appear. In many cases what may seem to be a simple characteristic may be the result of a combination of factors which require research to be carried on to determine exactly what is the effect of each individual factor.

The American Society for Testing Materials has issued a number of test methods covering evaluation of the properties of components of sandwich construction. These are primarily laboratory tests on small specimens. There has been little opportunity as yet to correlate these tests with actual performance experience in building use and they have not been used to any extent, therefore, by architects in the preparation of panel specifications. Further research, and correlation studies now taking place will, no doubt, overcome many of the objections that now hinder their application and make them available for specification purposes.

Aluminium Powders

(*Continued from page* 292)

terized by a bright, glossy surface that has the brilliance, lustre and colour desired. In ball milling, the lubricant is used to avoid welding the particles together under impact. An inert liquid such as mineral spirits is also added to form a carrier for the aluminium particles.

From the ball mills, the slurry goes through a filter to remove excess liquid and the resulting filter cake contains aluminium pigment with some mineral spirits. A metal content of 65 to 75 per cent. gives a stable paste suitable for use in most coatings.

Driers may then be employed to reduce the spirit content still further or will completely dry the mixture when dry powder is desired. Thus powder as well as paste can be made in the ball mills.

(*To be continued*)

FINISHING NEWS REVIEW

NEW APPROACH TO THE B.I.F.

Birmingham Chamber of Commerce consider the present Exhibition to be unrealistic

THERE is to be no British Industries Fair in 1958. This much was decided at a meeting at the Board of Trade in London between the President of the Board, the Rt. Hon. Sir David Eccles, K.C.V.O., M.P., and a deputation from the Birmingham Chamber of Commerce, led by the Chamber's president, Mr. R. P. S. Bache. The Minister of State, the Rt. Hon. Derek Walker-Smith, M.P., and the president of the Federation of British Industries, Sir Hugh Beaver, and other officials of the Federation were present, and the Town Clerk of Birmingham, Mr. J. F. Gregg attended as an observer.

Until last year, the Birmingham Chamber of Commerce has organized and financed the Castle Bromwich section of the fair and the Board of Trade has planned and handled the London Section. In 1956, when the government decided it would no longer stage the London section, Birmingham decided that in 1957 it would go ahead, alone, with the Castle Bromwich branch. The fair had been successful, but now other matters would have to be taken into account.

In the opinion of Mr. E. M. Clayson, chairman of the B.I.F. Executive Committee, if Britain becomes part of a European free trade area it would be unrealistic to maintain the B.I.F. to exhibit the products of British industry alone. A fair where British goods can be displayed alongside those of foreign competitors might be the best sort of fair to have, but if the B.I.F. does become international then it will be an anomaly for it to remain the sole responsibility of the Birmingham Chamber of Commerce. He did not think there was any doubt that British industry needed such a fair, and he thought its organization ought to be put on a wider basis.

The deputation told the President that they were in favour of internationalizing the fair, but it was impossible in the circumstances to organize this in time for 1958.

Sir David said he thought that the question of internationalization of the B.I.F. in future years would depend primarily on the attitude of British industry, and Sir Hugh Beaver agreed to make further enquiries about this.

A further meeting is to be held later, but at the end of this one Mr. Bachs said that the B.I.F. as such is already finished and that the Birmingham Chamber of Commerce were quite definite in their opinion that the future of the trade fair would have to be on an international basis.

Official Approval for Kanigen Plate

THE Kanigen plating process—now being operated on production scale in this country by Albright & Wilson (Mfg.) Ltd., who are also the sole licencees for the new process in the U.K., Eire and Denmark—has recently been given the Ministry of Supply Reference No. DTD/900/4505. The Ministry have at the same time indicated their approval of the application of Kanigen to certain carbon and low alloy steels, stainless steels and aluminium. Similar approval has been given by the Air Registration Board—Reference No. AI/5112/57.

A wide range of articles has already been plated in this country by the new process, as Albright & Wilson (Mfg.) Ltd. have had for some time at their Oldbury plant considerable capacity for jobbing plating work, and have been co-operating with industrial design engineers on the development of many specialized types of equipment for which the properties of Kanigen plate appear especially valuable.

I.V.E. MIDLAND BRANCH
Election of Officers

At a meeting of the Midland Branch of the Institute of Vitreous Enamellers held recently, Mr. L. Bayliss was elected chairman of the Branch for the next session and Mr. J. Bernstein, vice-chairman. The Branch committee is as follows: Messrs. Darrall Baldwin, W. Ball, and L. Reed. Mr. D. Sleath is honorary secretary.

U.S. MOTORISTS VOTE FOR STAINLESS STEEL TRIM

THE results of an independent survey into the American motoring public's preference for motor-car trim, sponsored by the American Iron and Steel Institute's Committee of Stainless Steel Producers, have now been published in a recent issue of the journal "Automotive".

The survey reveals that over 40 per cent. of the motorists polled were prepared to pay extra to have an external trim of the material they considered the best and that 57 per cent. favoured stainless steel for this purpose.

More than 35 per cent. of those interviewed indicated that they would prefer less than the present amount of trim on new cars, against 4·7 per cent. who would have liked more. Over 59 per cent., however, expressed content with the present amount.

The survey was made by an independent research group and every precaution taken to keep the sponsors' identity secret, and to avoid prejudicing the motorists interviewed for or against any particular type of trim material.

Firth-Vickers Stainless Steels Ltd., Europe's largest stainless-steel concern, confirm that British demand for strip and sheet to be made into motor-car trim has also increased. Although the peak period for excessive bright embellishments has now passed, possibly as a result of the poor quality chromium plate on post-war cars, the British motorist is showing the same interest as his American counterpart in preferring stainless-steel trim. British car manufacturers are extending their use of stainless steel for body trim, grilles, and hub caps, because of its long life and ease of cleaning.

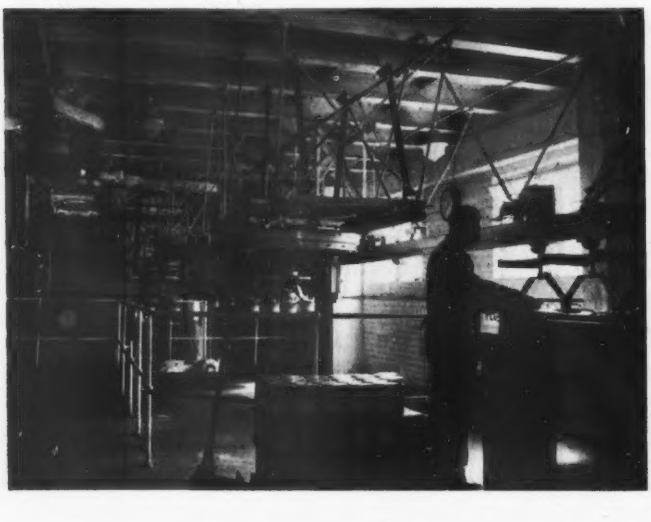
NEW MECHANIC
INSTALLED

Ingenious System Ad

ONE of the problems confronting a large paint manufacturer is the very large number of different items which have to be stored. For example, the Paints Division of I.C.I. Ltd., at Slough, has a total of some 7,000 stock items to be kept readily available in order to maintain an effective customer service. Moreover, the large volume of orders dealt with each day comprises a considerable number of different items of which the number of tins per item is small.

Loading conveyor trays in the filling department.

Conveyor trays arriving in the warehouse from the filling department being emptied.



These facts impose considerable difficulties when it comes to a matter of devising a storage method which provides sufficient space, together with economy in handling and adequate speed of despatch. The problem at Slough was aggravated by the fact that the site available for the erection of a warehouse measured only 400 by 330 ft.

The solution ultimately adopted involved the erection of a four-storey building with a capacity of about one million gallons of paint provided with a highly ingenious handling and conveyor system. The construction of the warehouse itself was interesting in that the entire weight of the four-tier storage racks rests on the ground, and not on intermediate floors; all flooring above ground level is hung between the racks. This method of construction effected considerable economies in building costs.

In order to reduce manual handling to a minimum a "Stanrun" overhead chain conveyor, supplied by George W. King Ltd., conveys the tins of paint from the filling department of the paint factory to the warehouse storage area and subsequently from the storage area to the packing and despatching departments. The paint is carried on trays suspended from trolleys running on the chain, which travels at 40-45 ft. per min., each tray being able to carry up to five gallons of paint.

A particular feature of the system is that each tray is provided with a control key which is set so that at each transfer point it is automatically directed to a predetermined destination. Thus, when tins are being loaded at the filling lines, which are destined for storage on the third floor, the control key is given an appropriate setting so that the tray is automatically shunted off at the correct floor where the tins are removed and stacked by hand according to type, size and colour.

NDLING PLANT INT WAREHOUSE

C.I. Ltd. (Paints Division)

A conveyor system along the central gangway on each floor level is used to assemble orders in the storage area and deliver them to the packing area. The warehouse is divided into zones, each of which has an assembler responsible for making up orders (or even part orders) relating to the type of paint stored in his area. He receives his instructions from the conveyor operator by a pneumatic tube system. Then, using a specially designed trolley incorporating a step ladder, he collects the different items specified on the order sheet and takes them to a loading station in the gangway which has earlier received, automatically, an empty tray. When he has loaded the tray, he operates a control to send it back on to the conveyor, first marking the order number on a small flag and adjusting the control key. This key selects the marshalling line, of which there are eight at the end of the conveyor system, for which the tray is intended. Each assembler always sends his trays to the same marshalling line.

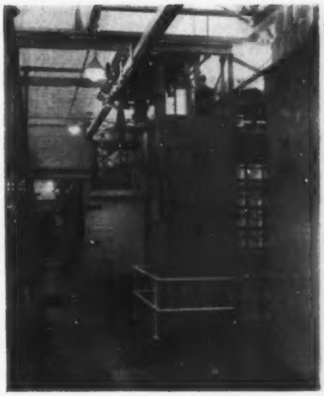
After the assembler has completed his part of an order he returns the document by pneumatic tube to the control position where its receipt signifies that the goods are on the track. The conveyor operator who previously sent the documents to the zones and receives them back after completion is stationed at the exits of the marshalling lines.

Back on the conveyor, the tray automatically reaches its selected marshalling line. At the same time, other trays relating to the same order will be arriving in other marshalling lines from the other assemblers. When the order is complete, the conveyor operator sends all the trays from the marshalling lines off on to a transfer conveyor. This takes the trays to storage loops in the roof of the building where they circulate while awaiting checking and packing.

When their turn comes, the trays come down to the checkers, who unload the tins on to a roller track. The order is then packed in cartons unless it is for local delivery.

After packing, the completed orders are taken, when the vehicles are ready, on slat conveyors to the loading bays. Here, by operating push-button controls, the operator can extend the conveyors out into the waiting vehicles.

The new warehouse was designed by I.C.I. Paints Division technicians and the principal contractors were Geo. W. King Ltd., for conveyor equipment, Constructors Ltd., for the four-storey racking installation, and The New Conveyor Co. Ltd. for the slat conveyors.



(Above, left.) One of the loading stations along a storage gangway at which tins of paint are put into empty conveyor trays which have been automatically delivered from the conveyor track. Loaded trays from such points are conveyed to the marshalling lines.

(Above, right.) Orders assembled in the marshalling lines are placed on roller track and conveyed to the packing point, where the tins are placed in cartons taken from the overhead chutes.

(Right.) Tins of paint for local delivery are carried by a retractable slatted conveyor into the delivery van.

ORGANOTIN COMPOUNDS AS FUNGICIDES

THE annual Italian Tin Conference, held in Milan on May 29, was entirely devoted this year to papers dealing with organotin compounds, and scientists attending the Conference heard the latest results of international research in this important field.

The Conference, which was jointly arranged by the Tin Research Institute, Greenford, and the Italian Chemical Society, was under the presidency of Dr. G. Morandi, President of the Lombardy Section of the Italian Chemical Society and Vice-President of Montecatini.

Organotin compounds have opened up a vast new field of scientific research. Their industrial applications were surveyed by Dr. E. S. Hedges, Director, International Tin Research Council. After a brief, introductory history of the subject, in which he paid tribute to the work of Dr. G. J. M. van der Kerk of the T.N.O. Organisch Chemisch Instituut, Utrecht, Dr. Hedges went on to say that, at the present time, by far the most important commercial use of organotin compounds is as stabilizers in the plastics industry.

The biocidal properties of some of these compounds show great promise, said Dr. Hedges. The main task was to produce new compounds so as to selectively kill one form of life while leaving others unharmed.

This could provide new fungicides and insecticides for pest control for growing crops, wood preservation, moth-proofing wool, rot-proofing jute, mould-proofing paint, eradicating soil pests and many other industrial purposes.

Dr. G. J. M. van der Kerk, whose researches, undertaken on behalf of the International Tin Research Council, have formed the basis of all modern developments of organotin compounds, described his work to the gathering of prominent Italian scientists.

Methods of analysis of organotin compounds were discussed by Dr. J. W. Price, head of the Chemistry section at the Tin Research Institute, and Dr. Forquet, a member of the staff of Montecatini spoke on "Use of Organotin Compounds in Plastics".

HEAVILY CORRODED STEELWORK PREPARED FOR PAINTING BY USE OF OXY-ACETYLENE FLAME CLEANING

A COMMON problem in such buildings as breweries, plating shops and dye-works is the amount of corrosion caused by moisture forming on structural steelwork, and this was encountered by The Cheltenham and Hereford Breweries Ltd. at their brewery in Cheltenham.

Caustic vapour rising from the bottle-washing machines was causing moisture to rise to the roof girders, forming rust and corroding the steelwork. In addition, moisture was causing pitting in the concrete ceiling with fungus beginning to form there as a result.

The problem came to a head recently when the firm decided to extend the bottling stores by installing a new bottling line to meet an increase in the demand for their beer.

It was essential that all rust should be removed from the surface of the steelwork in the new structure so that the paint would bind firmly to the metal and so overcome corrosion due to the vapour.

The company discussed the problem with their local building contractors, S. C. Morris and Son Ltd., and a firm of structural steel preservation specialists, Stevens and Stevens of Reading, were called in to advise on the matter.

One of the proposals for eliminating the rust was that the British Oxygen oxy-acetylene flame cleaning process should be employed.

British Oxygen Gases Ltd. were therefore called in from Birmingham and work began on cleaning the new steelwork and also existing steelwork which had become corroded. The existing bottling stores had been erected in 1937 and over the years flakes of rust had formed on the girders.

After all rust had been removed by the use of the oxy-acetylene flame-cleaning torches and while the steelwork was still warm a special type of rust-inhibiting primer on a red-oxide/zinc-chromate base was applied. When dry, a further coat of this primer was given, followed by two coats of undercoating and one coat of gloss finishing. The last three coats were on an Epikote base and were both fungicidal and alkali-resisting.

After the flame-cleaning torches had destroyed the fungus in the ceiling (separating the surface plaster from the concrete in the process) two applications of a fungicidal solution were applied. The concrete was then replastered and the new plaster received two applications of the fungicidal solution, which penetrated to ensure a sterile basis for painting. Two coats of Unicote Primer (Fungicidal) were then given, followed by two coats of undercoating and one of finishing. All were Epikote-based and similar to those applied to the steelwork.

The paint used in conjunction with the flame cleaning process was supplied by Thos. Parsons and Sons Ltd., of London.

Further information on the Flame Cleaning Process is contained in Technical Information Booklet No. 11 issued by British Oxygen Gases Ltd., Bridgewater House, Cleveland Row, London, S.W.1.

TECHNICAL AND INDUSTRIAL APPOINTMENTS

Mr. L. S. Lowery, formerly Birmingham office manager of the **Electro-Chemical Engineering Co. Ltd.,** Forsyth Road, Sheerwater Trading Estate, Woking, Surrey, has been appointed sales manager of the company.

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Mr. G. E. Clifford, B.Sc., Ch.E., A.I.Ch.E., has been appointed technical director of **Air Control Installations Ltd.,** Ruislip, Middlesex. He has been chief engineer of the company since 1936 and recently attended the Atomic Energy Conference in the United States, taking part in technical discussions with the American Air Filter Co., the associates of Air Control Installations Ltd in America.

Mr. H. C. S. Brand, M.A., A.I.I.A., has been appointed works director after holding a similar post with Addis Ltd. for the past six years.

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Mr. C. E. Ramsden, managing director of C. E. Ramsden and Co. Ltd., has been elected President of the **Society of Glass Technology.**

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Mr. Douglas Brown will join **Black and Decker Ltd.,** Harmondsworth, Middlesex, in August as contracts sales manager. He is at present technical director of Attwood Statistics Ltd., whom he joined in 1950. Previously, he has been appointed to the boards of Bedford Attwood Ltd. and Television Audience Measurement Ltd.

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Mr. B. E. Wheadon, M.B.E., formerly chief technical representative of **Desoutter Brothers Ltd.,** The Hyde, Hendon, London, N.W.9, has been appointed technical sales manager of the company.

Colonel D. G. N. Lloyd-Lowles has been appointed chairman of the **Amber Group of Companies,** of which he has been a director for some time. He succeeds the late Mr. Arthur Mortimer who died earlier this year. The group includes Amber Chemical Industries Ltd., the Amber Chemical Co. Ltd., Amber Oils Ltd., Amber Pharmaceuticals Ltd., Causeway Reinforcement Ltd., and Charles H. Windschuegl Ltd. Mr. John Cronk is managing director.

Colonel Lloyd-Lowles is also a director of Electric and General Industrial Trusts Ltd., and of Firth Cleveland Ltd., and is chairman of The Tap and Die Corporation Ltd.

Mr. G. C. Baker, secretary of the group, has been appointed to the board of **Amber Chemical Industries Ltd.**

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Mr. I. C. R. Bews, B.Sc., A.R.I.C., previously a sales representative for the company in Birmingham, has joined Mr. C. G. T. Prince, M.A., B.Sc., A.R.I.C., as a sales representative in the London office of **British Titan Products Co. Ltd.,** York.

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Mr. A. D. Buckland-Nicks has been appointed by **Shell Chemical Co.** as industrial field sales controller to control all sales divisions and to act as deputy for Mr. P. J. March, B.Sc., A.R.I.C., the new marketing manager (industrial).

Mr. R. A. Atkinson has taken up a senior position with the chemical industry administration of the **Shell Petroleum Co.** The posts of northern and southern regional managers, formerly held by Mr. Atkinson and Mr. Nicks, will cease to operate.

FUTURE FOR LEAD IN VITREOUS-ENAMELLED ALUMINIUM

COMMENTING on a recent forecast of a rapidly expanding market for vitreous-enamelled aluminium, made by the Commercial Research Committee of the Porcelain Enamel Institute's Aluminium Division, Robert L. Ziegfeld, secretary of the Lead Industries Association, pointed out that practically 100 per cent. of the vitreous enamels used on aluminium contain a substantial percentage of lead compounds. These lead compounds impart the low melting temperatures necessary for vitreous enamels to be applied to aluminium, as well as good weathering and other characteristics.

He said that, while this market for lead is still very new and comparatively small, based on the P.E.I.'s estimate of 23,000,000 sq. ft. of vitreous-enamelled aluminium by 1961, the tonnage of lead involved by that time will amount to hundreds of tons.

He emphasized the importance to the lead industry of this new development which is now finding uses in the building industry, signs, small appliances, transportation and military applications. It is expected that by 1961 many more uses will be found, including application in the automotive industry.

COMPANY TIE-UP TO BUILD PROCESS PLANTS

IT is jointly announced by John Laing and Son Ltd. and The H.K. Ferguson Company of Great Britain Ltd. that the two companies are forming a separate association in the name of Laing-Ferguson to provide a complete and comprehensive construction service to the chemical, processing, and manufacturing industries. The integration of all aspects of construction under a single controlling responsibility has already proved a means of achieving a significant and much needed speed up of completion schedules in this class of work.

The Laing organization is well known both in Britain and in the Commonwealth for its achievements in building and heavy civil engineering work for industry. Notable industrial projects in recent years include the twin atomic piles in West Cumberland for Britain's first plutonium-producing establishment, heavy foundations for the cold-reduction mill at Abbey Works, Margam, the world's largest knitting-wool factory for Patons and Baldwins Ltd. at Darlington, extensive construction work for Britain's oil refining and petro-chemical industries, and mills, factories, process plants and research installations for many other industries. In Africa the Company has played a leading part in the construction work of gold mining and uranium plants both in the Orange Free State and in the Transvaal.

The H. K. Ferguson Company of Great Britain Ltd. is a subsidiary of The H. K. Ferguson Company of America, an organization of world-wide repute for its experience in providing complete process plants, manufacturing plants and laboratories for a wide range of industries, in many parts of the world.

The H. K. Ferguson Company of Great Britain Ltd. is already established in this country and has worked successfully for such companies as Thomas Hedley and Co. Ltd., and for Imperial Chemical Industries Ltd. Also they have collaborated with John Laing and Son Ltd. on the new foundry for the Ford Motor Company at Dagenham.

RUSSIA AND THE PEACEFUL ATOM

A New Film

A RUSSIAN-MADE film, "Atoms for Peace", describing how nuclear energy is being put to work for medicine, industry and science in the Soviet Union, was shown recently in London.

The film is well-made in colour, and has an excellent commentary in English. It deals with the Russian five-year plan to harness atomic energy, but the date of production is obscure so that a comparison with what we know has already been done in this country is difficult.

Beginning with an explanation in diagrammatic form of the reaction that produces nuclear energy, it then shows how this can be harnessed and controlled.

In the industrial field, examples are shown of the uses of radio-active isotopes in plastics manufacture, cotton mills and geological prospecting, the detection of internal faults in metal sections, the control of density mixtures, and as counters and tracers in quantity and quality control.

Radio-active isotopes are shown being used as a marker to identify coils of sheet steel. The coils are marked before pickling and remain on the metal throughout its subsequent treatment, so that at the end of the process the particular origin of the coil can be easily traced.

There are also scenes of a Russian nuclear power station and the commentary states that "within the next five years" the output from this source will be two to 2½ million kW.

The film closes with a model of a marine icebreaker which in the full scale is to be driven by atomic energy.

If it achieves no other purpose, the film will obviously make a tremendous impact in those areas of the world where methods of education are confined to visual aids.

Running time is 75 minutes. The colour version is on 35 mm. film, but a 16 mm. black and white edition is also available. The film can be hired from Plato Films Ltd., 18 Greek Street, London, W.1.

TRADE and TECHNICAL PUBLICATIONS

"Kanigen Plate": A new descriptive leaflet published by Albright and Wilson (Mfg.) Ltd., 1 Knightsbridge Green, London, S.W.1, gives information on the properties and applications of Kanigen plate. Recently introduced to this country, Kanigen nickel plate is a nickel 8 per cent. phosphorus alloy deposited without the application of an electric current. This hard and wear and corrosion-resistant coating can be applied not only to most metals in general engineering use, but also to glass, ceramic and thermosetting resins. A particular advantage of the Kanigen process is that the plating can be deposited at fully controllable thickness into all recesses of a complex shaped object. The wide range of articles that have already been plated in this country by the process, includes aircraft valves, chemical valves, heat exchanger tubes, laundry equipment, pumping equipment designed to handle corrosive liquors and certain specialized types of military equipment, including some specifically designed for operation in tropical conditions.

"High Vacuum Pumps": It is nearly 25 years since the first Speedivac pump was manufactured by Edwards High Vacuum Ltd., Manor Royal, Crawley, Sussex, and today the dozen or more different models, together with large industrial high vacuum pumps displacing up to 20,000 litres per minute are all described in a 24-page booklet issued by the company.

Sufficient information has been included in the new catalogue to enable users to select high vacuum pumps for standard laboratory and industrial applications and several pages are devoted to the various accessories which are available for the "Speedivac" range, including magnetic valves, vacuum condensers, moisture traps and manifolds and non-return float valves.

"Irradiated Polythene Tape": The improvement in the properties of polythene after exposure to high energy radiation have already been reported, and fundamental research into the effect has been carried out in the Hinxton Hall Research Laboratories of Tube Investments Ltd., The Adelphi, London, W.C.2.

It will be some years before the full possibilities of this method of producing chemical synthesis are thoroughly evaluated, but already the industrial implications for some of the work have been realised. As a result, T.I. is now making available to interested companies pilot plant quantities for testing of an irradiated polythene tape or film which has been proved to possess a number of important industrial applications.

The special properties of the tape and a list of its possible uses are given in detail in a technical report circulated by the company.

"Historic Tinplate": An echo of the tragedy and heroism of the last Antarctic Expedition of Captain Scott resounded at a small ceremony staged recently by the Tin Research Institute, Fraser Road, Perivale, Greenford, Middlesex, and described in the summer number of its quarterly Journal, "Tin and Its Uses". The occasion was the opening of a number of food cans cached in the Antarctic by Captain Scott in 1911 and discovered and brought back to England last year. Mr. Peter Scott, son of the explorer, sampled the contents of some of the cans which were found to be in an excellent state of preservation, attack on the tin coating being very slight.

The issue also contains a brief account of the sixth symposium on tin held in Paris in March, which was devoted to a discussion on the Nature and Characteristics of the Tinplate Surface.

"Chemicals for Industry": Most of the alkaline cleaners used by the metal finishing industry contain silicates and phosphates of sodium, and one of the companies which has developed a very large industry in the supply of this type of material is Joseph Crosfield and Sons Ltd., of Warrington, Lancs. From its start as a soap manufacturing concern in 1814, the company has become an important producer of industrial chemicals, and the complete range of its chemical products is summarized in a comprehensive and excellently produced reference catalogue issued by and freely available from the company.

"Lead": The current issue of the quarterly Bulletin "Lead", issued by the Lead Industries Association, 60 East 42nd Street, New York 17, highlights the versatility of lead in metal finishing applications by citing two examples. One is the application of the newly developed vitreous enamelled aluminium panels to the exterior of one of New York's newest skyscrapers—the enamelling of the aluminium being made possible by the incorporation of lead compounds in the enamel formulation.

The use of red lead paint on the structural steel work for almost 1,000 miles of roads is emphasized, and the shop primer paint specifications used by each State through which the road passes are given.

Latest Developments in PLANT, PROCESSES AND EQUIPMENT

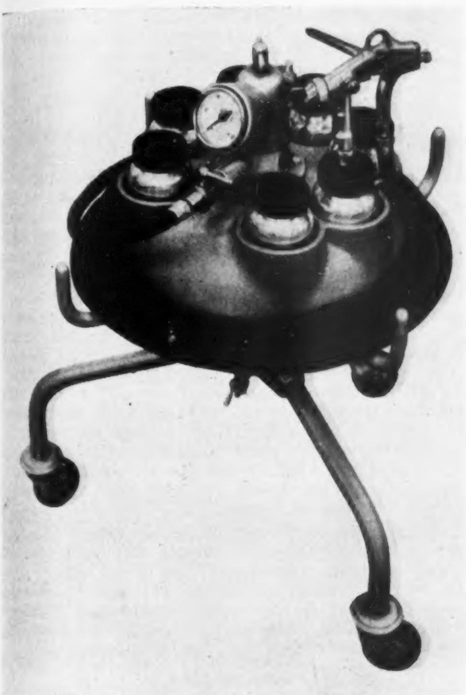

Fig. 1.—Portable touching-up kit.

Fig. 2.—Guide roller for conveyor belts.

Portable Touching-up Kit

A NEW portable kit for touching-up paintwork, called the V.2579 (Fig. 1), has been introduced by Alfred Bullows and Sons Ltd., Long Street, Walsall, Staffs.

It allows the operator to spray a range of colours with a minimum loss of time in changing from one colour to another.

Basically, it is their L/910 spray gun, but it also has seven 5-oz. aluminium containers, making provision for thinners and six colours to be carried at the same time.

The equipment includes a built-in reducing valve, and a suitable length of hose. It is mounted on a castored trolley easily handled by one man.

Guide Roller for Conveyor Belts

A NEW type of guide roller for conveyor belts that has been successful in the United States and the Scandinavian countries has now been introduced to Britain by The British Wedge Wire Company Ltd., Academy Street, Warrington, Lancs.

The guide is a revolving "capstan", ball-bearing mounted and having a limited travel axially. Mounted at a forward angle of 30 deg. at intervals along the belt edge, its concave bearing surface offers the maximum area of contact with the belt. Its ability to move axially allows it to follow the oscillations of the belt across the carrying idlers and it is claimed that the new roller can be used to prolong indefinitely the life of an otherwise worn-out belt.

The "Guidler", as the roller is called, is available in four sizes. Fig. 2 illustrates its use with a belt having a badly frayed edge.

Material Handling Pump

THE present-day practice in this country is to buy finishing materials in bulk containers and to transfer the material to other containers for use in the shop. Logical practice is to use the material straight from the bulk containers, especially as paint manufacturers are now prepared to supply their paints at controlled viscosity ready for use. To meet this need for equipment, and enable

(*Continued in page* 306)

paint to be used straight from the drum Alfred Bullows and Sons Ltd., Long Street, Walsall, Staffs, now offer a suitable pump.

This is the Model 41-8500 Bullows-Binks Material Handling Pump. It can supply paint to a gun or guns straight from the container, to a dead-end system for non-pigmented materials, or to a circulating system where the materials to be handled may settle out in the lines. It will provide a steady flow of material at a high rate with a long, smooth pump stroke, giving delivery on both the up and down movements. Low maintenance cost and long life are assured by very low operating speeds.

Depending on the application, the unit is suitable for supplying material to at least six spray guns over a medium-size circulating system, providing that pipe sizes are adequate. Again depending upon the type of material in use, it has a delivery pressure up to 150 lb. per sq. in. for a main line air pressure of 80 lb. per sq. in. Air consumption is ½ to 1 cu. ft. per min. per gallon and the pump will empty a full 55-gallon drum of SAE 20 oil in less than 5 minutes. The pressure control is built in, by which the material pressure may be set as required and the pump will automatically compensate for line variation, ensuring that as additional guns are turned on, extra material is delivered to maintain the specified main line pressure.

New Method to Remove Oxidation Scale

A NEW method of removing the scale formed on steel girders, sheets and plates during rolling or heat treatment has been developed by the Walterisation Company Ltd., Purley Way, Croydon.

Designed to obviate the necessity for expensive immersion installations the new product, "Waltergel", is a pickling solution contained within a thixiotropic jelly which can be applied to the scaled surface while the object being treated is *in situ*. Stirring with a stick causes the jelly to partially liquefy and it can then be applied with a brush. After leaving for about half-an-hour the spent solution can be washed off with water.

Plastic-Sheathed Thermometer

TOOL Treatments (Chemicals) Ltd., Colliery Road, Birmingham Road, West Bromwich, Staffs, have recently introduced a new vapour-pressure thermometer, claimed to be water, steam and acid proof, which has its bulb and capillary sheathed in plastic.

The instrument, which has a 4-in. easily read dial and is housed in a bakelite case, can be wall mounted, and its temperature scale can be supplied to specification.

A scale reading from 30° to 150° F is designed for the plating industry.

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